ADVENTURES IN SCIENCE

BOOK VI

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ADVENTURES IN SCIENCE SERIES

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Adventures in Science

Book VI

(New Revised Edition)

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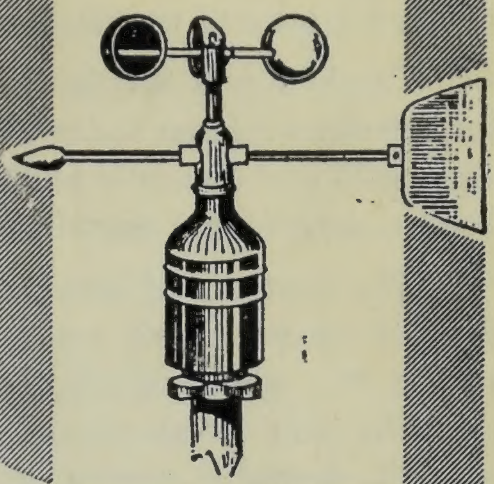

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SCIENCE SERIES

Adventures in Science, Book VI, is one of a series planned to encourage and guide Science activities in the primary and intermediate grades of the elementary school.

Teachers will find in these books a wealth of useful material for activities related to the study of wild flowers, gardening, Arbor Day, wild and domestic animals, birds, insects, soils, sky, weather, health, magnetism, electricity, and other science topics.

The contents of each book are arranged in units planned to develop basic science concepts and generalizations. The books offer a very complete science course, organized to not only introduce the pupils to an extensive body of information, but to develop, as well, desirable science interests and appreciations, skills and abilities, and habits and attitudes.

ADVENTURES IN SCIENCE BOOKS

Come Out of Doors, Book I
Outdoor Pathways, Book II
Looking Around Us, Book III
Open Doorways, Book IV
Adventures in Science, Book V
Adventures in Science, Book VI

Acknowledgment

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Hugh M. Halliday photo.

"Spike", a young porcupine, seems to know where to go for a good meal.

Young wild animals soon learn to be friendly with, and to trust, people who are friendly with them.

Make friends of the animals around your home and school. If you watch them carefully, they will "tell" you many interesting things about themselves.

PLANNING AHEAD

It was the first day in the new term at Western School. The pupils were glad that Miss Hughes, their teacher, had arranged for a science lesson.

First, a few pupils told about their summer science experiences. There were too many to be described in a single lesson. Norman had watched a mother duck raise her family in a pond near his father's farm. Mary and John told about some of the animals in a zoo they had visited. A collection of leaves was displayed

These pupils and their teacher are carefully planning their year's science program. They are careful to make their plans fit into the right seasons so that many activities can take place outdoors. (Bruce Pendlebury Photo.)

by Gordon who said he was sure he now knew the names of most of the trees in the district.

Miss Hughes suggested that it was important to plan early the year's work in science. For Grades V and VI she had written on the blackboard a list of topics very much like the main headings in the CONTENTS of this book, pages three and four. "This is the program suggested for the year," she explained, "but we do not need to follow it exactly. At what do you think we should start first?"

"I'd like to begin with electricity," said Bill, "because there will be experiments to do and things to make." Immediately Nancy spoke up. "If we do that," she exclaimed, "we'll be into cold weather before we can do anything with the plant and animal topics. Then most of the plants and animals will be gone for the winter." Bill thought a moment, then he said, "You're right, the experiments will have to wait."

John and Gordon both said that all of them should try to see and do as much outdoors as possible.

"I think we ought to make some plans about the *way* we should work," suggested Mary. "What do you mean?" asked Ronald. "Well, for one thing", explained Mary, "we should be as sure as we can that we have correct information about things before we make up our minds about them."

"I am very glad you mentioned that, Mary," said Miss Hughes. "Giving attention to the way we work will make our science classes more useful as well as more interesting."

HOW WESTERN SCHOOL CLASSROOM WAS IMPROVED

Have you ever seriously thought about the appearance of your schoolroom? Are you proud of it or not?

The pupils of Western School knew that a bare room does not make a good classroom. They often planned ways of making their school as attractive as possible. They wanted it to express their own ideas.

"Almost half the time we are awake is spent in school," exclaimed Gladys one day. "We should make it as pleasant as we can."

"Let us get a few plants," suggested Wesley. After some discussion, the other pupils agreed.

Of all things that may be used to make our school rooms cheery and pleasant, none can take the place of a few plants. What a different atmosphere a few touches of natural beauty and color give to any room! If the walls are dull and the woodwork faded it is doubly important to hang bright pictures on the wall, and to fill the windows on the sunny side of the room with plants.

Is the growing of plants in school possible during the winter months? In some schools no doubt it is not. But in schools where even a small fire is kept on overnight, a little extra care in covering the plants before leaving each day will in most cases be sufficient protection against frost.

John offered a good suggestion. "If the school becomes too cold," he said, "we can take our plants home. I'd like to have a few."

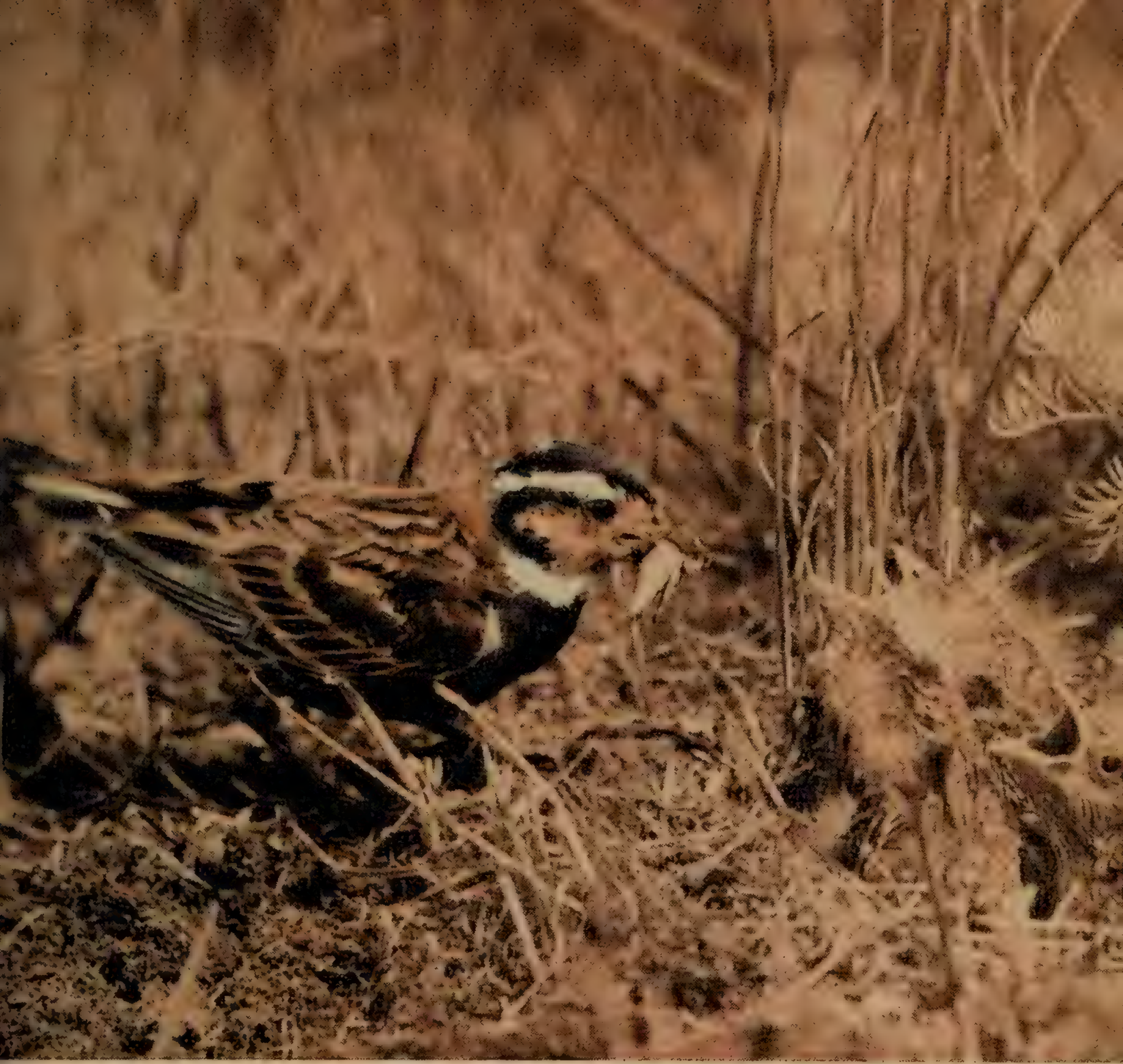
"Even a few are worth while," agreed Miss Hughes. "In fact a few well cared for are better than too many. It is worth the effort! But remember, our enjoyment of our plants will depend a good deal upon the care we give them. Let us see what we can do!"

"We'll have to find out what care plants need," said two or three pupils almost together. After some planning, the pupils made a list of the things they needed to learn, such as watering, temperature, and so on. Then they started a list on the blackboard. What one pupil learned was checked against what others found out. Soon the class were sure that they had accurate information about how to care for house plants. Here are some of the things they learned:

Most plants thrive best at a *temperature of about 60° F.* Do not keep them in parts of the room that are likely to be a great deal warmer than this. An even temperature is best.

Moist air is desirable for plants. Try to arrange a pan of water somewhere in the room where it will be kept slightly warm and thus will readily give off moisture into the air.

Your plants must be *watered regularly and properly.* The amount and frequency of watering depends upon the kind of plant, its leafiness, the sandiness of the soil, the size and kind of the container, and the temperature and dampness of the air in the room. You must examine your plants every day to see if the soil is dry. Keeping the soil too wet is just as bad or worse than allowing it to become too dry. Give each plant sufficient water each time to moisten the soil to the very bottom, then let the soil become fairly dry before watering it again. Do not allow water to stand in saucers or jardinieres. Use natural soft water if possible. Stirring up the soil occasionally to a depth of about ½ inch is a good thing to do.



The Chestnut-collared Longspur is a common bird on the open prairies. Many people do not think that there are many birds on the prairies, but they are wrong. There are numerous birds in these areas, if we but look for them and know them: Killdeers, Gulls, Horned Larks, Meadow Larks, Longspurs, Vesper Sparrows, and many others.

The Chestnut-collared Longspur is a member of the Sparrow Family. It is slightly smaller than a House Sparrow, and can be recognized by its black breast and underparts, distinct chestnut-colored patch at the base of the neck, characteristic face marks, and white outer tail feathers. It returns to the prairies in late April and adds life and interest to the prairie scene.

Pupils in prairie schools have many opportunities to become acquainted with interesting birds. Watch for them as you travel to and from school. (Photo by courtesy of W. H. Carrick.)

The *foliage should be washed* occasionally to remove dust and small insects. Use a fine spray or soft sponge, or place plants out in a warm gentle rain.

Keep your plants in *bright sunshine.* Turn them from day to day so that all sides receive light. If they are not turned they grow to the light and develop unevenly. Foliage plants do not require as much light as flowering plants, and ferns need still less.

Watch your plants carefully for the appearance of *injurious insects*, such as aphids or plant lice, mealy bugs, red spiders, etc. Healthy plants are not so likely to become infested with insects. Geraniums seem to be only rarely attacked. If aphids appear, wash your plants in soapy water or spray them with Black Leaf 40 which may be purchased from florists. Mealy bugs (flat, slow-moving, white insects) must be washed off.

It is important to *pick off regularly dead leaves and withered blooms.* Remove, also, dead plant material and other rubbish from the top of the soil. Such material is not only unsightly but it attracts insects as well.

Make friends with your plants. If not too heavy, pick each one up occasionally, pick off dead leaves and withered blooms, examine carefully for harmful insects, stir up the soil, water, and return to the window with a different side to the light. Arrange your plants tastefully. Place the taller one to the centre. Pay attention to color arrangement as well. Keep the plant shelf or window sill clean. Attention to little things such as those just mentioned, will help greatly to keep your plants healthy and attractive.

How To Grow a Plant from a Slip

It was suggested to the pupils of Western School that it would be interesting to grow a few plants from slips.

Although spring and fall are probably the best times to slip plants, a number of common house plants, such as geraniums and foliage plants, can be slipped successfully at almost any season.

Choose strong, healthy young shoots, three or four inches long. Cut them off just below a joint. Remove all but three or four leaves. Many common slips can be started in clean sand or soil. Do not plant too deeply. Keep the sand moist, *but not soaking wet.* It is a good plan, after the first two or three days, to allow the sand to become quite dry before watering it again. For a day or two at first, shade your newly planted slips from the direct rays of the sun, but do not keep them in the dark; if you do they will decay and die. Sometimes it is helpful to cover each slip with a tumbler (or a box of slips with a sheet of glass) for a time at first. The glass keeps the air moist around the young plant so that it does not lose too much water until it has roots to gather what it needs. After several weeks, each slip will have developed roots and may be transplanted.

Plant your rooted slips in flower pots, tin cans, or chalk boxes bound with wire. The container must have holes in the bottom for drainage. Carefully pile small stones or bits of crockery over the holes and partly fill the container with soil. Use a fairly rich soil to which a little sand has been added. Spread out the roots of the slip. Plant so that about $\frac{2}{3}$ of the stem is underground. Fill the container to within $\frac{1}{2}$ an inch of top. Press soil lightly about the roots. Water well. Keep shaded for a day or two, then place in a sunny window.

Questions

1. Explain how to start roots on a geranium slip. What kind of slip should be selected? How are roots developed? How should the slips be treated during the first few days? What is the best method of watering? What time is required to develop a good root on a slip?

2. Describe a suitable container in which to plant your rooted slip. How is the drainage opening in the bottom protected?

3. What kind of soil is best for potting slips?

4. Explain how to plant your slip. Why is it important to spread out the roots? Why should the container not be filled to the very top with soil?

5. Describe a good method to follow in watering house plants. Do all plants require the same amount of water?

6. What conditions must be provided to ensure healthy growth of house plants? How are these conditions provided in the schoolroom or at home?

Making an Everlasting Bouquet

At this time of year you should bring bouquets of snapdragons, asters, cosmos, zinnias and other autumn flowers to brighten your classroom. Would you like to learn to make another kind of bouquet, one that will continue to be interesting and attractive all through the fall and winter?

To make an everlasting bouquet, collect a variety of interesting dry plants in early fall. Some suggestions are heads of several kinds of grain, corn tassels, bittersweet, teasels, milkweed pods, sumac, mountain ash berries, cat-tails, strawflowers, and dried weeds and grasses. Try to get plants of several different colors and heights. To obtain different colors, a few of the plants may be dipped in water paints and dried.

Arrange your plants in bouquets. Do not overcrowd the plants in each bouquet. Suitable containers are vases or cans of dry sand into which the stems may be pressed.

UNUSUAL FLOWERS

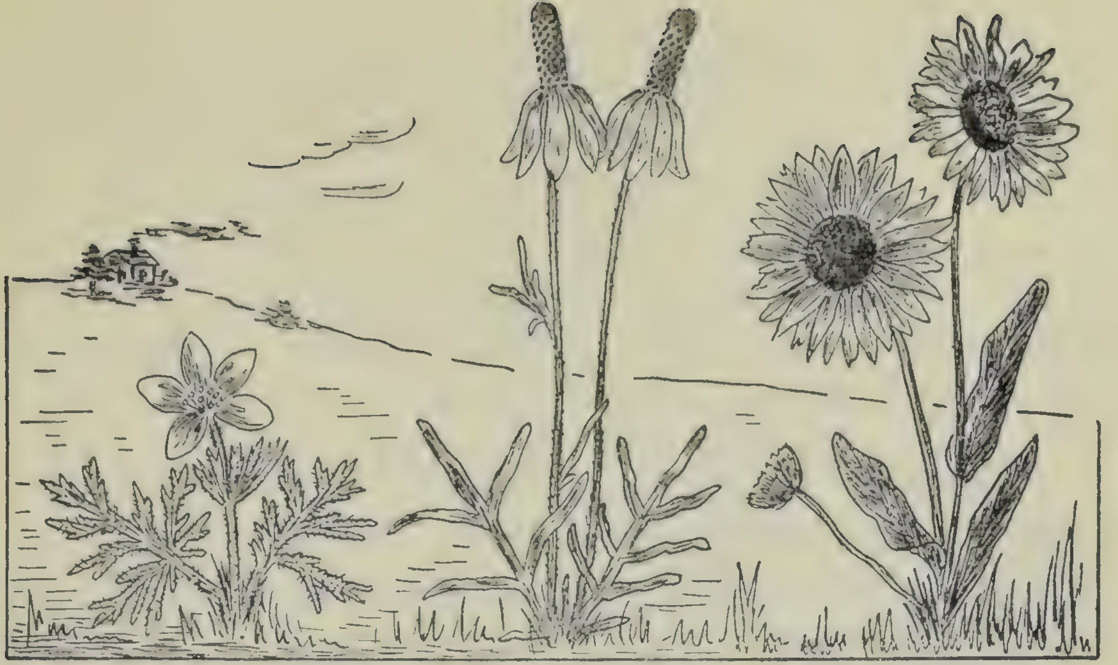
Betty and Tom had stopped to gather a bouquet of dark *yellow* daisy-like wild flowers growing in a thicket along the roadside. Suddenly Betty called out, "Look, Tom, I've found a *red* one." It was a beauty, too! Tom and Betty were highly delighted at having discovered it. Betty was particularly pleased because it was her sharp eyes which had seen it first.

No two living things are exactly alike. For example, if you examine carefully two flowers which at first appear to be similar, you will find that they are different in some respects. But not uncommonly, the differences are very marked and striking. In a group of plants that usually bear yellow flowers, there will be sometimes a plant with red flowers. Or occasionally in a number of plants with single flowers, a plant with double flowers will appear. Very often the flowers that are so greatly different from the others, are much more beautiful and interesting. Let us try to find unusual plants among the common plants in our locality. Those described in the following paragraphs are a few among which surprising differences are likely to appear.

The Coneflower and Gaillardia

Two wild flowers of interest in our study of variation are the *coneflower* and *gaillardia*. Both these flowers grow in open fields and along roadsides. They are found very commonly in the Prairie Provinces.

Both the coneflower and the gaillardia are members of the great Sunflower family. In each case, the



Crocus Anemone Coneflower Gaillardia

flower really consists of a large number of small flowers, or *florets* grouped together in a head. The centre of the flower head, called the *disc* is made up of small, dull-colored florets. The disc is surrounded by a row of bright, showy florets called *rays.*

In the coneflower, the disc forms a tall column, usually greenish-yellow in color. Around this disc grows a row of dark yellow rays. The leaves of coneflowers are deeply cut into from five to nine divisions.

You will find wide variations in coneflowers of the same species. The central disc varies greatly in size and shape, and the rays differ in color and number. Try to find one with a double row of rays. Sometimes we find a red or brownish-purple coneflower.

The central disc of the gaillardia varies from a light green to a reddish-brown or purple color, depending on the age of the flower. The broad, overlapping rays are a rich golden-yellow color, often splashed at the base with dark red. Great variation in color, size, and number of rays may be found in gaillardias. How many different flowers can you find?

Variations in Garden Flowers

In early fall we have in our flower gardens many flowers that offer interesting studies in variations or differences. Be sure to look for some of these variations.

Examine the zinnias in your garden. How do they differ in color, shape, and size? Sometimes you will find a zinnia with a large central disc and only one or two rows of rays.

French marigolds often show differences in color among the flowers on the same plant. Can you find a plant having broad stripes of color on some flower heads, with other heads having only narrow stripes of color?

Other garden flowers show interesting variation. Sweet William may have flowers of several colors all growing on the same stalk. Asters may show differences in the length and shape of the petals. The usual number of petals on the sweet pea flower is five, but you may find some with as many as nine petals. How many other variations can you find?

Using Variations to Improve Plants

We have learned that in a group of the same kind of plants, one or more may be different from the others. The flowers of one may be a more beautiful color, or one plant may be stronger and better able to grow in poor soil.

Scientists have learned that if the seeds of these better plants are sown, the new plants retain the good characteristics of the parent plants. This is one way that has been used to improve our crops. By watching for superior plants and using the seeds from these to plant the new crop, improved plants and crops can be produced.

Problems and Things To Do

1. Make a study of wild flowers common in your locality to learn about the differences that may exist among those of the same kind. Study the blossoms particularly. If the plants mentioned in the preceding paragraphs grow in your locality begin your study by examining specimens of them. Keep notes.

2. Collect specimens of wild flowers showing striking differences.
   (*a*) Make drawings in colors.
   (*b*) Press and mount your specimens.

3. What differences or variations have you found in garden flowers of the same kind?

4. How has man made use of the differences that occur in plants of the same kind to improve his garden and field crops? Give examples.

Some Flowerless and Seedless Plants

One day in Western School Anne mentioned that she had been reading about flowerless plants. At once a discussion started. Some pupils thought that all plants have flowers and seeds. Others said that trees have no flowers.

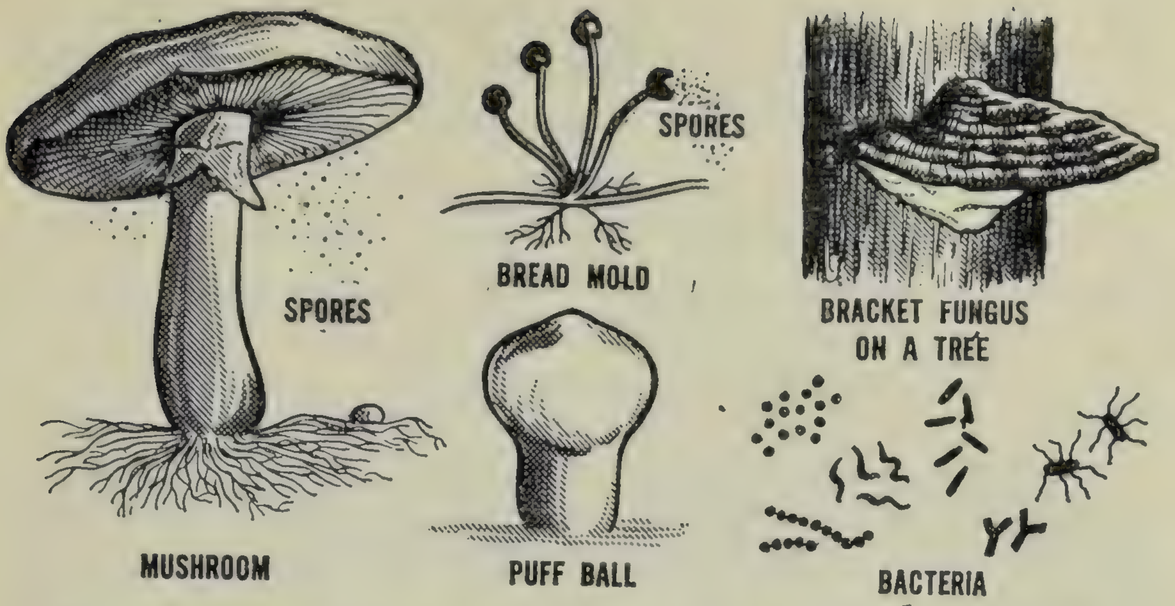
The pupils who spoke about trees were wrong, because trees do produce flowers in the spring. But, there are plants, ferns and mushrooms for example, that

With microscopes, similar to the one this scientist is using, tiny forms of life, such as bacteria, can be magnified many times. In this way their appearance and ways of living and growing can be seen and studied. (Bausch and Lomb Optical Co. photo.)

have no flowers. (See paragraph on page 167.) Other flowerless plants are so small that they can be seen only by using a powerful microscope.

The Smallest Plants—Bacteria

Do you know that there are a great many plants so small that they can be seen only by the use of a powerful microscope that will magnify them about 1,000 times? These tiny plants are called *bacteria*



Some flowerless plants. The bread mold and the bacteria are greatly magnified.

(pronounced bak-tē′-ri-a). They are the smallest plants and are far more common and numerous than such plants as geraniums, nasturtiums, potatoes, and others with which you are familiar. Bacteria have no roots, branches, leaves, or flowers. In fact each bacterium (singular of bacteria) consists of one cell only, about one 25 thousandth ($\frac{1}{25000}$) of an inch across. But they are plants, nevertheless, and grow very rapidly in the presence of food, moisture, air, and warmth.

Where do bacteria grow? They grow almost everywhere—on all *food*, in *water*, in *soil*, in *our bodies*, and in the bodies of other animals and plants as well. They are in the air, on your hands, in the dust, and many, many other places, and are able to begin growing and multiplying as soon as favorable conditions are found. Many bacteria are able to live in our throats, our lungs, our stomachs, and in other parts of our bodies. When growing in such places, they cause diseases, such as *diphtheria*, *tuberculosis*, *typhoid fever*, and many others.

But fortunately, of the 1,500 different kinds of bacteria known to scientists, less than 100 are harmful. Most of them are harmless and *many are exceedingly useful.* Bacteria in the soil help to change "plant food" substances into forms that will dissolve in water. Bacteria in cream cause it to ripen for churning.

Problems and Things To Do

1. Dissolve some unsweetened gelatine in boiling water. Pour some of this gelatine into small *clean* dishes and cover immediately with *clean* saucers. When the gelatine has cooled, try the following experiments:

(*a*) Leave one dish undisturbed. Do not remove the cover even to look at it.

(*b*) Raise the cover of another and touch the surface of the gelatine lightly with an unwashed finger. Replace cover immediately.

(*c*) Wash the hands thoroughly with soap and water, and touch the gelatine in another dish with a clean finger. Cover at once.

(*d*) Sprinkle a little dust on another. Cover at once.

(*e*) Leave one exposed to the air for a time. Replace cover. Label each dish, and put away in a *warm, dark* place for a few days. Then examine. What do you observe? The gelatine in dishes (*b*), (*d*), and (*e*) should show light-colored, cloudy growths in or on the gelatine. In dishes (*a*) and (*c*) there should be very few scattered growths or none at all. The growths that develop are really colonies, each containing hundreds of bacteria.

2. Prepare two dishes of gelatine and proceed as outlined in (*d*) and (*e*) Experiment No. 1. Keep one dish in a cool place. Keep the other in a warm place. What happens and why?

3. Bacteria are the cause of milk souring. Place two small bottles of milk away, one in a cool place, and the other in a warm place. Which sours more quickly? Why?

4. What are bacteria?

5. Where are bacteria found?

6. Why should we always wash our hands well before eating?

7. Why should we never bite our finger nails or put our fingers into our mouths?

8. Why should wounds be cleaned and bandaged as soon as possible?

9. How can our food be protected from bacteria?

Molds

Often when bread is placed away in a warm, moist place tiny plants begin to grow upon it. Some of these plants have a white, thread-like appearance. Others are bluish-green and powdery. Still another is black. These plants we call *molds*. The mold most likely to grow on the bread is the larger, white, thread-like one, which is known as *bread mold*. How do molds grow? How do they get on bread?

On the outside of the bread, bread mold appears as a fine, criss-crossed mass of white threads. Other threads grow into the bread in search of food. In a few days, tiny white globes, no larger than the head of a pin, develop at the tips of the threads in the air. Each globe is a *spore-case* filled with thousands of very, very small bodies called *spores*. Later the spore cases ripen and turn black. Then they break and the spores are carried far and wide through the air. When a spore falls on moist bread in a warm place, it begins to grow, producing a new mold plant. Spores act like seeds, but they are not seeds. Most of the plants we are familiar with grow from seeds. But there are many plants which do not grow from seeds but from spores. Molds are among the plants which grow from spores. There are usually spores present in the air.

Problems and Things To Do

1. Place small slices of bread on small dishes. Moisten two slices, and leave two dry. Sprinkle dust from furniture in the room on all slices. Cover all with inverted glass tumblers. Place 1 dry slice and 1 moist slice away in a warm, dark location. Place the other dry and the other moist slice away in a dry, sunny location. Observe carefully after two or three days.

2. Place a little preserved fruit juice in two cups. Sprinkle a little dust on one, but not on the other. Cover both cups and place in a warm, dark location. Observe after several days.

3. In Experiment No. 1, when did mold first appear? On which piece of bread was mold first seen?

4. Why does the mold not appear on some of the slices of bread? What conditions seem to favor the growth of the mold (moisture or dryness, cold or warmth, light or darkness, etc.)?

5. When did small, white spore cases first appear on the bread mold? When were they ripe and black?

6. Try to examine mold under a strong magnifying glass. Describe its appearance.

7. What occurred in Experiment No. 2?

8. Where does mold come from?

9. Tell what you know about spores.

10. What harm is caused by molds?

11. What should we do to prevent the growth of molds in our food?

12. Name all of the substances or things on which you have seen molds growing.

PLANTS AND ANIMALS HELP EACH OTHER

A new problem was introduced in the science class when Janet reported, "I read that all animals depend upon plants for food."

"How can that be true?" asked Gladys. "Wolves, weasels, and lions don't eat plants. Their food is other animals."

"That is so," replied Janet, "but if wolves eat deer and rabbits, these animals feed upon the leaves of trees and grasses. If there were no plants, there would be no food for any animals."

"You have stated what you think very well, Janet," said Miss Hughes. "Not only do animals depend greatly upon plants, but animals help plants in many ways. How they do, can be a very important and interesting problem for us to work out together."

How Do Animals Depend Upon Plants?

Think of the many animals which depend upon plants for food. The daily menu of a horse or cow includes grain (the seeds of plants) and hay (dried grass). In the woods, the deer and moose feed upon grass and the tender leaves of trees and shrubs. The squirrel stores away for winter use quantities of nuts which are the fruit of certain kinds of plants. Bark of trees and the leaves of grasses and many other plants are favorite diet of the rabbit. Name other plant-eating animals.

Large numbers of birds, such as the Oriole, Kingbird, and Meadowlark feed upon insects. They, too,

This father Redstart has brought a beakful of insects to his young one. The Redstarts are chiefly insect eaters. How do they depend upon plants? (Hugh M. Halliday photo.)

may be said to depend upon plants for their food. Why? The insects, which the birds eat, feed upon plants. Therefore, if there were no plants, there would be no insects for the insect-eating birds.

During the cold, winter weather, what do birds find to eat? Watch them to find out! You will see them clinging to the tops of weeds projecting through the snow, searching for stores of seeds. You will find them in the cotoneaster, Russian olive, honeysuckle, chokecherry, saskatoon, and other shrubs, feasting on dried fruit hanging on the branches. They will also be busy in the Manitoba maple, ash, and other trees cracking open the winged fruits to secure the kernels inside. It is great fun to watch the birds cracking the shells of seeds. Try to observe Goldfinches and Sparrows cracking the shells of sunflower seeds in the fall. Many birds, such as Goldfinches, Sparrows, Grosbeaks, Snowbirds, Juncos, and others depend to a very great extent upon seeds and fruits for their food supplies.

Squirrels not only depend upon plants for food, but find a home and protection among the trees. (Harold Vickers photo.)

The fact is, plants make all of the food required by the animals of the earth. Green plants are the only living things that can combine materials taken from the air, water, and soil to form food. Some animals, as we have learned, feed directly upon plants, and others feed upon plant-eating animals. If the plants in the world were to disappear the animals would soon disappear as well.

A great many birds build their nests in trees and shrubs. The branches support the nests, and the leaves hide the nests and the mother birds from their many enemies. The substances used in the construction of the nests are also largely plant material: rootlets, grasses, bark, and moss. Trees and shrubs are the night roosting places, where the birds are safe from ground animals.

Insects lay their eggs and hang their cocoons and chrysalises upon plants. Caterpillars and grasshoppers eat leaves and grass. Many insects hide among the foliage of numerous plants.

Remember!

Science is a "do" subject. Do not be content to just read about it. ABOVE ALL, DO NOT JUST COPY PARTS OF YOUR TEXTBOOK INTO YOUR NOTEBOOK.

TRY TO WATCH LIVING THINGS OUTDOORS. Read your textbook. Look for other examples of your own. Discuss what you learn with your classmates.

Watch birds feeding. Find out the kinds of plants and parts of plants that furnish them with food.

Look for insects feeding upon plants, such as caterpillars, grasshoppers, aphids, beetles, and others.

Watch butterflies sticking their long tongues into flowers. For what are they searching?

How Do Animals Help Plants?

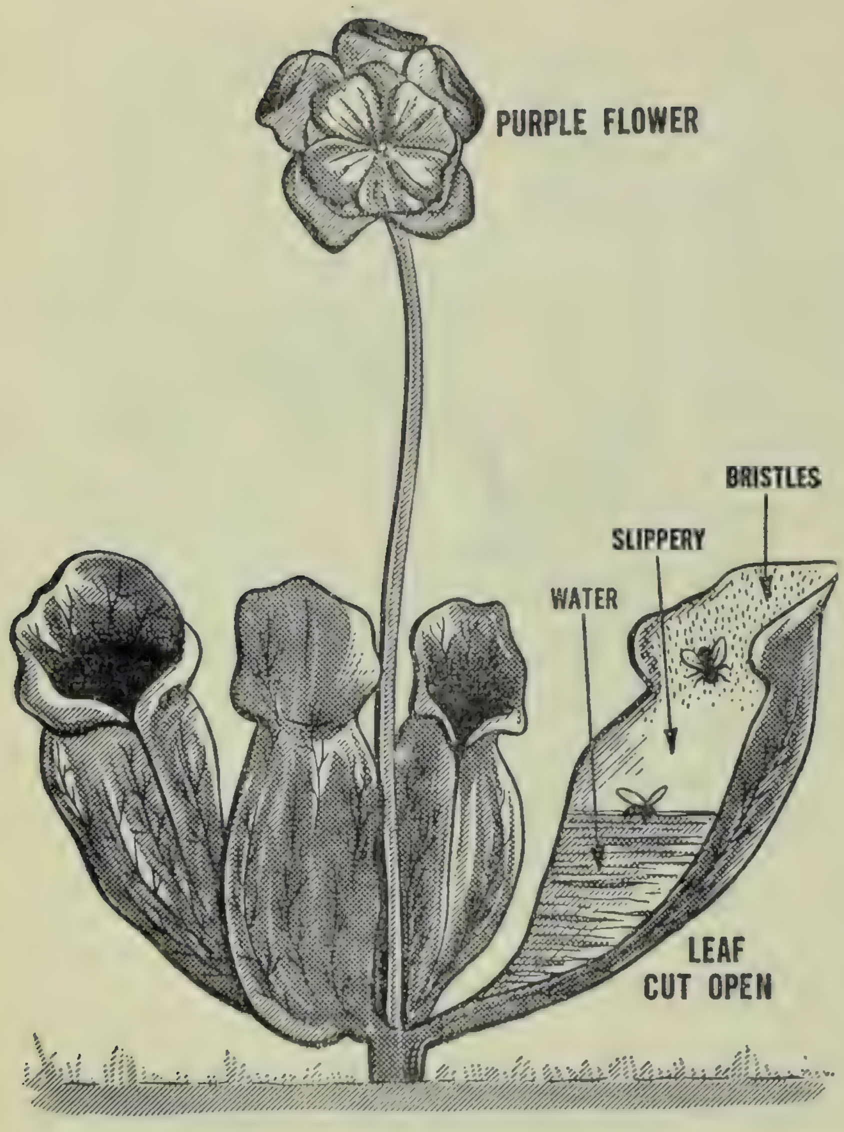
Watch bees busily visiting flower after flower. Each flower serves lunch in the form of nectar to its bee visitors.

Nectar is a sweet, honey-like liquid from which the bees make honey. But, the bees "work" for their lunch in an interesting way. As they push into the flowers, their bodies become covered with pollen, the yellow powder produced in flowers. It happens that many plants require to have the pollen carried from one flower to another, as it is important in the formation of seeds. Therefore, the bees in transferring pollen from flower to flower are performing a valuable service for the plants. Many plants, such as clover, depend upon bees entirely to spread their pollen.

Many plants produce great quantities of seeds, and they like to have their seeds scattered over as wide an area as possible. Some of these plants produce seeds equipped to catch rides in the fur and wool of animals. Have you not walked through the fields and later found many seeds stuck tight in your stockings? Seeds of plants, such as the blue burr and burdock, may be carried in the coat of an animal many miles from the parent plant. The animals, therefore, in this way help the plants in an important manner. Squirrels, in their nut-gathering activities, also help to scatter seeds. Birds, too, when dining on fruit, do much to scatter the seeds of the fruit-bearing plants.

Explain how the bee and the nasturtium flower help each other.

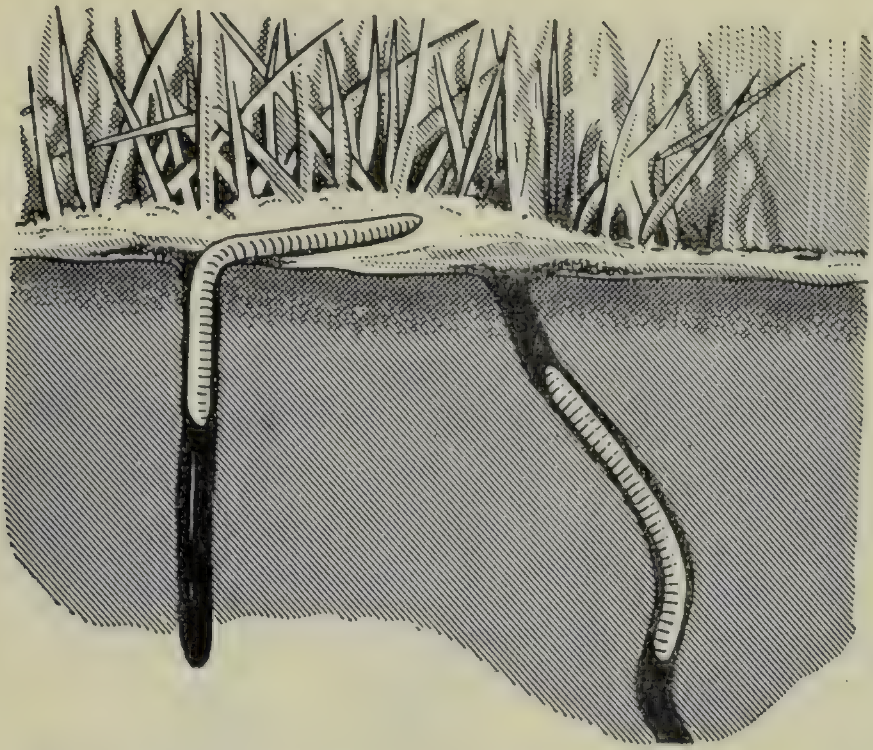
There have been stories told of kings, who, because the birds stole some of their fruit, had all the birds killed. Soon, the whole country was swarming with insects. The insects then began to eat all kinds of plants to the extent that it appeared all of the plants would be destroyed. Even today, insects would in a short time cause even more damage than they do to plants of all descriptions, were it not for the war



Some plants "eat" insects. One is the *pitcher plant.* Its leaves are shaped like pitchers, and are usually partly filled with water. Insects enter the leaf, and fall into the water. Their bodies are digested and provide food for the plant.

waged by many of the birds upon plant-eating insects. Woodpeckers dig beneath the bark of trees in search of wood-boring insects. And in our gardens, many birds hunt for cutworms and beetles which destroy plants. What an important service to the plants is thus rendered by the hard-working birds!

How does the earthworm help plants? These lowly, but valuable animals burrow into the soil, loosening it up so that air and water can enter. Their food is the soil itself. As the soil, which they eat, passes through their bodies it is ground up and changed into forms which make it richer and a better growing place for plants. Earthworms also bring tons and tons of new soil to the surface of the ground. If there are earthworms in your garden, look upon them as one of the best friends of your garden plants.



The earthworms are soil makers and cultivators.
They help the farmer and gardener.

When a farmer raises live stock, he has manure to spread on his soil. Thus he can, with the help of his farm animals, enrich the soil and improve it as a growing place for plants.

Problems and Things To Do

1. List all the ways you can think of in which plants help animals.

2. List all the ways you know of in which animals help plants. Mention bees, birds, earthworms, and domestic animals.

3. If there were no plants in the world, there would be no hens, robins, sheep, or dogs. Why?

4. Do you think that one kind of animal could live on the earth entirely by itself? Give a reason for your answer.

HOW PLANTS HELP US

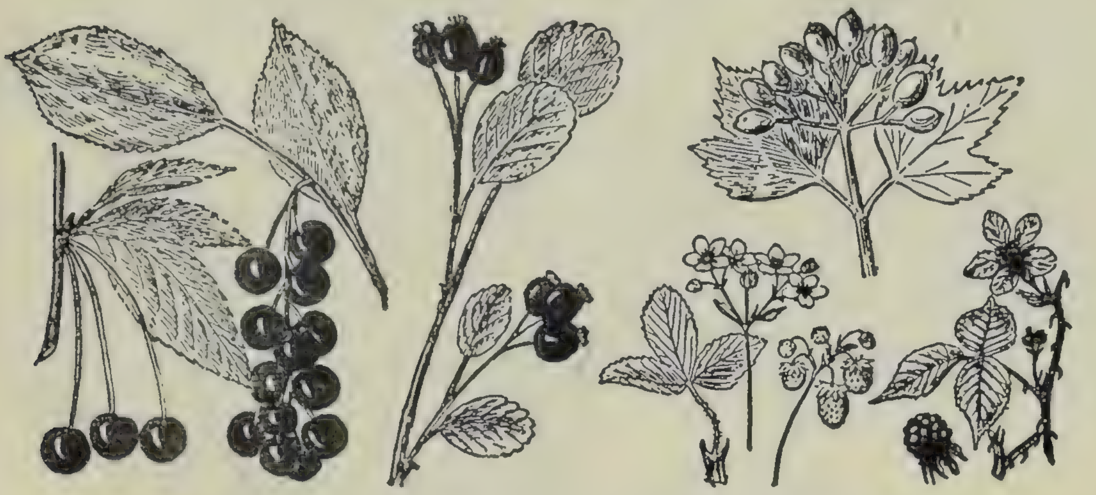
Try to imagine the world with no plants. How strange it would appear! There would be no towering trees, no green grass, and no colorful flowers. And, as we have learned, there would be no animals because all animals depend upon plants for food. Even flesh-eating animals live upon animals which feed upon plants. Study your own meals. Bread, pies, cakes cookies, sugar, jams, and preserves are prepared largely of plant material. Meat, milk, and eggs are products from animals that live on plants. It is not difficult to realize that if there were no plants, there would be no other life upon the earth, at least not in forms as we have them at present.

We all know how very much trees add to our comfort and happiness. We know, too, a good deal about plants we use for food. There are a number of other important ways in which plants of various kinds are useful to us. HOW MUCH CAN YOU LEARN FOR YOURSELF?

Common Wild Fruits

Have you ever found a patch of early *wild strawberries?* They grow in rich moist soil in partly shaded locations. The plants are very low and the leaves are divided into three parts or leaflets. The leaflets are slightly toothed. Slender runners may be seen extending out from the plants. The flower is white. Most people think the wild strawberry is more delicious than the cultivated varieties. What do *you* think? Certainly no wild fruit is more welcome than the wild strawberry.

Another well-known and popular wild fruit is the *raspberry*. These plants grow from 2 to 5 feet high and have woody stems very often covered with prickles. The leaves are divided into three egg-shaped, sharply toothed leaflets. In July and August, the bushes are usually heavily loaded with juicy red fruit. The flowers are white. Look for wild raspberries in thickets and on the hillsides.



Choke-cherry
Pin-cherry Saskatoon

High-bush cranberry
Strawberry Raspberry

In the spring the roadsides and woods of the Prairie Provinces are made attractive by the showy white flowers of the *saskatoons*. Saskatoons are shrubs or small trees 4 to 12 feet in height. They are common in poplar thickets and on hillsides. The leaves are almost circular and coarsely toothed above the middle. Both birds and people welcome the clusters of purplish-black fruit which ripen during July and August.

Choke-cherries are another common wild fruit. The plants are tall shrubs with grayish-brown bark. The flowers are white, and the leaves are egg-shaped and sharply toothed. As the fruit ripens it is at first red, but later becomes dark crimson in color. Choke-cherries, eaten raw, dry and pucker the mouth. They are popular for making wine and jelly.

In the fall, the leaves of saskatoons, choke-cherries, and pin-cherries become beautifully colored in rich reds and browns.

In many low-lying and thickly wooded places, the *high-bush cranberry* grows. It is a shrub, 5 to 10 feet high, with very broad, three-pointed leaves. The flowers grow in flat-topped clusters and the outer flowers are white and showy. The ripened fruit is bright red and has a flat seed in the centre. The fruit is pleasantly sharp in flavor and used a great deal for jellies. The high-bush cranberry is entirely different from the low-bush and other varieties of cranberries.

Cloth and Rope from Plants

Linen thread and linen cloth are manufactured from the fibres of the *flax* plant. There is also linen in certain kinds of paper. The flax plant has delicate blue flowers. A field of flax in bloom is a very beautiful sight.

From the fibres of the seed pod of the *cotton* plant, we make cotton thread and cloth. As you know, the silk-like cloth, *rayon*, is produced from wood.

Hemp is a fibre plant sometimes grown in this country. It is a tall plant (6 feet or more) with large many-pointed leaves. The fibres of hemp are coarser than the flax fibres, and are used in the manufacture of sailcloth, rope, and similar materials, in which strength is important.

How Plants Help to Make Soil

People often go to the woods for good soil. Why? The leaves falling to the ground year after year, and decaying, fill the soil with a large supply of plant material. Decayed plant material in the soil is known as *humus*. In the humus are substances required by plants. Plant will not grow well if there is not a good supply of humus in the soil. That is the reason gardeners add manure to their soils. Manure is largely plant material.

Not only does the addition of plant material to the soil add "plant food" but the fibres bind the tiny soil particles together and prevent them from being blown by the wind. When the settlers first broke up the rich prairie soils they were not troubled with soil drifting. The soil was rich in plant fibre which held the soil together.

Years and years ago when the earth was young, the surface was covered with solid bare rock. But gradually the rock was broken up into fine particles and mixed with plant material to form soil. Plants also help in breaking up the rocks. A tiny seed falls in a little soil in a crack in a rock. A new plant soon begins to grow in the crack. As its roots grow larger they press with great force against the sides of the crack and finally the rock may be split in two.

The Storage of Food In Plants

In the fall, the tops of grass plants die, but new leaves will grow from the roots the following spring. In the garden, too, many plants that will grow again the following year, die down to the ground in the fall. How do these plants make a new start? The answer is, of course, that the roots, which do not die, contain stores of food. This food keeps the plants alive during the winter, and also gives them a start in the spring. All plants which live through the winter store food in the fall. In what part of the plant would you look for the stored food?

Be Sure to Try These Experiments

1. Put a very little *starch* in the bottom of a glass tumbler. Fill the tumbler with water. Carefully add three or four drops of tincture of iodine. What color appears?

IMPORTANT

An experiment is something we do or try out to find an answer to a question or problem. Keep in mind that unless we work carefully, our results may not be accurate and we may not have the correct answer. See Mary's suggestion on page six.

Note: When we wish to know whether or not there is starch in a substance, we pour a little iodine on it. If a dark purplish-blue color results, we know that starch is present.

2. The food that is stored away in plants is largely *starch*. Test the following to see if there is starch in them: (*a*) a slice of potato, (*b*) a slice of onion, (*c*) a slice of parsnip or carrot. (*d*) Soak some bean seeds and wheat kernels in water over night—in the morning split them in two, and drop a little iodine on one half. Test other seeds and other parts of plants.

3. Remove the shell from a sunflower seed. Crush the kernel on a piece of white paper. Warm the paper slightly. Notice the grease spot that is formed. This tells us that there is *oil* or *fat* in seeds. Test flax seeds and corn for oil.

4. Did you ever have a *winter indoor vegetable garden?* Cut the top (about ½ inch) from a carrot, a turnip, and a beet. Place them in a saucer and add water until they are almost covered.

Keep them in a warm, sunny place, and do not allow them to become dry. Soon you will have a delightful garden. The leaves that will grow will be smaller and more delicate than the leaves of carrots, turnips and beets growing outdoors. In what part of these plants was the food that gave the new leaves a start?

This field of grain will supply much food, not only for many people, but possibly for livestock, birds, and other animals. (Canadian Departmentof Interior photo.)

We have now learned that food is stored in many parts of plants.

(*a*) *Underground stems or tubers.* We found food stored in the potato. It is an underground stem. The "eyes" are buds that will produce new plants when the potato is planted. The swollen roots of begonias and dahlias are *root tubers.* They are enlarged because of their stores of food.

(*b*) *Bulbs.* Cut an onion lengthwise and examine it. Notice the roots, the short stem, the bud in the centre, and the *layers of thick fleshy leaves.* The leaves are rich in stored food for the use of the bud as it starts to grow into a new plant after the onion is planted. Dig up a tulip or daffodil bulb after it has finished flowering. It was plump and firm when planted. What is its condition now? What has happened to its supplies of food?

(*c*) We found food stored in the carrot and other *fleshy tap roots*. Carrots, beets, turnips, and parsnips are biennials, or two-year plants. They spend the first year in storing food in their roots. The second year, the stored food is used to help the plant to produce seed. If you plant a carrot in the spring, and examine it later when the plant has produced seed, you will find that it has become small and shrunken. Its supply of food has been used by the plant.

(*d*) Some plants store food in the *stems*. Examples of such plants are asparagus, kohlrabi, and sugar-cane. Other plants, such as lettuce and cabbage, store food in the *leaves*. Rhubarb and celery are examples of plants that store food in the *stalks of the leaves*.

(*e*) *Seeds*, of course, are rich in stores of starch, oil, and other foods. Seedlings, or new plants, cannot at first make food for themselves. They must depend upon supplies in the seeds from which they grow.

We make use of our knowledge about food storage to provide ourselves with many kinds of food from many kinds of plants.

Problems and Things To Do

1. Make a list of the uses we make of plants (other than as food). Mention as many kinds of plants as you can.

2. Make a list of foods you eat that have in them materials secured from plants.

3. Describe the appearance of the earth if there were no plants. Show how all animal life depends on plants.

4. How are plants useful to birds? Name several plants that supply birds with food. Name plants that would be useful for planting in our gardens in order to help the birds.

5. What flowers are visited by bees? What two food materials do bees secure from flowers? Name some plants of special value to bees.

6. Mention several varieties of wild fruit that are common in your locality. Tell how each can be identified.

7. In the fall make a collection of leaves of the choke-cherry, saskatoon, and pin-cherry. Try to find leaves with the most vivid colors. Do not collect single leaves, but small sprays of four or five leaves. Press and mount them in as attractive arrangements as possible. In small frames, they will make beautiful decorations for your classroom.

8. The soil has been formed by the breaking up of the rocks. Tell how plants have helped to pulverize the rocks. Tell, too, how plants help to enrich the soil and prevent it blowing.

9. Why do plants store food? What food is stored chiefly? Why are plants that store food valuable to us?

10. In what parts of plants is food stored? Give examples of common plants to illustrate your answer.

11. How can you tell whether or not there is starch in a carrot, seed, bulb, etc.?

12. Do you think that we could get along very well without plants? Give reasons for your answer.

HOW ANIMALS ARE USEFUL TO MAN

The Struggle for Life

Life for a great many of the animals of the woods and fields is often very difficult and hard. They must battle continually for their very existence. Fierce animal enemies must be avoided, and very frequently unfavorable conditions such as cold and lack of food must be overcome.

Each animal has become especially fitted to live its particular kind of life. Polar bears have a heavy coat of fur to keep them warm during cold Arctic winters. The white color of their coats makes it more difficult for their enemies or their prey to see them against the white background of snow and ice in their northern hunting grounds. The squirrel has a long, bushy tail which helps him leap safely from branch to branch. His claws and feet are fitted for running up and down tree trunks. The ways in which animals are fitted to live successfully in their surroundings are known as *adaptations* (ad-ap-tā′shons). The wings of birds are adaptations for flying. The webbed feet of the muskrat are adaptations which help it to live in the water. Your own hands and fingers are adaptations that enable you to write, button your clothes, pick up pins, and do other things which you could not do without fingers.

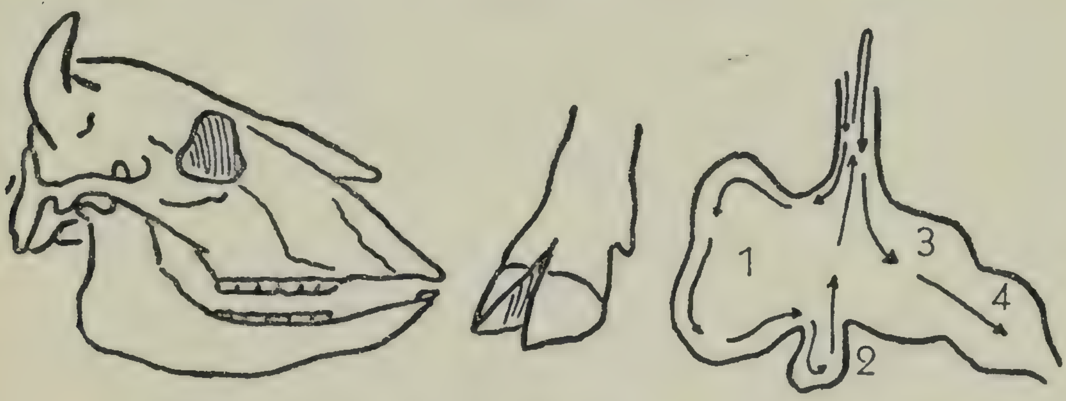
A Challenge: You can observe many adaptations for yourself. Watch different kinds of birds hunting for food. Watch cats, muskrats, gophers, and others.

Observe caterpillars, butterflies, bees and other insects. BE ABLE TO TELL YOUR CLASS ABOUT ADAPTATIONS OF ANIMALS THAT YOU HAVE ACTUALLY OBSERVED.

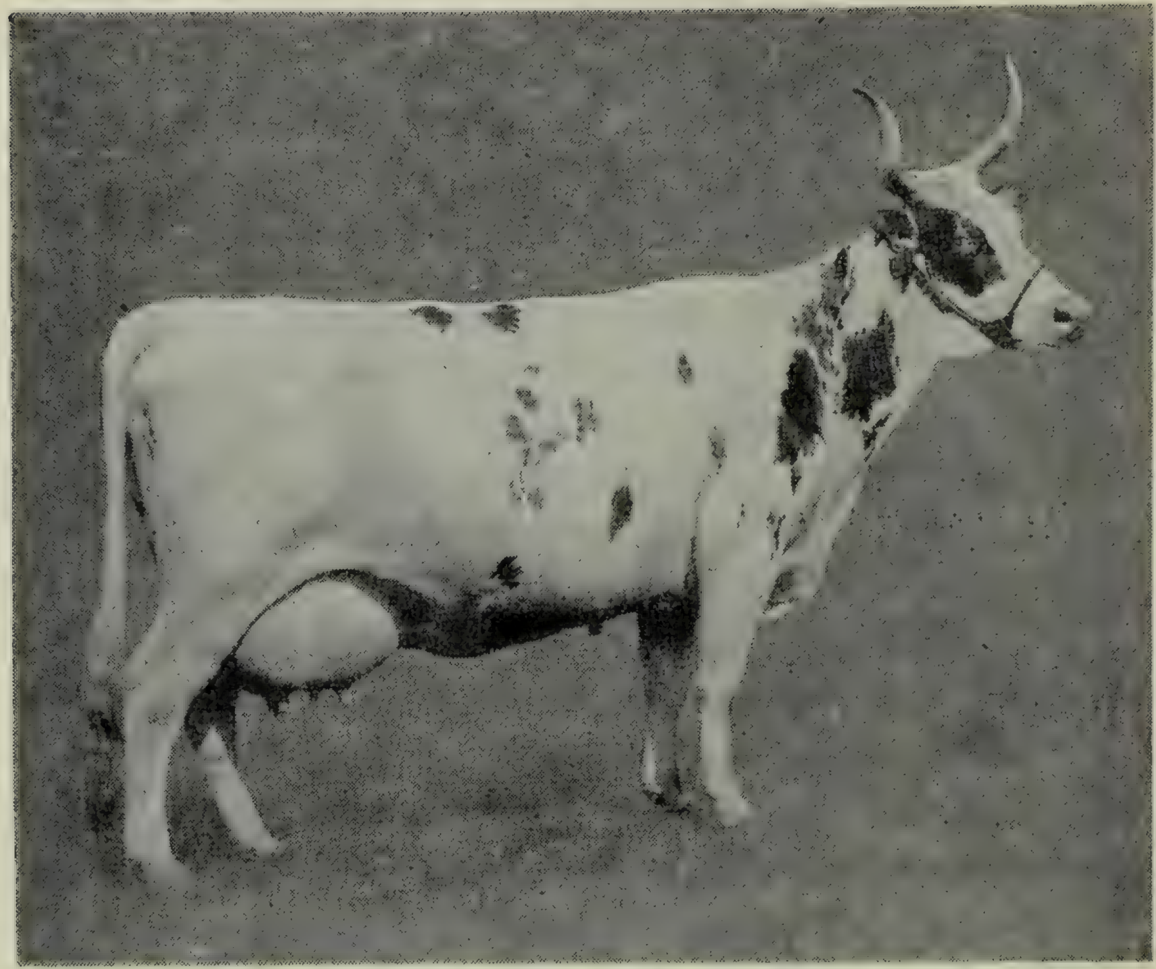
Even domestic animals possess interesting adaptations which we can discover by observing them as we see them from day to day. The dog's broad deep chest, long strong legs, claws and padded feet, keen sense of smell, and sharp cutting teeth fit him to be a successful runner and hunter. The pig's tough snout enables him to dig for roots and other food of which he is fond.

What Adaptations Have Made Domestic Animals Useful to Man?

The Cow: Cattle like to graze in the mornings and evenings, then seek a shaded spot or stand knee-deep in water as they chew "the cud". Long ago, wild cattle found that the best grass grew in the open fields. But here also lurked deadly enemies. Consequently the cattle seem to have formed the habit of hurrying to the grasslands, quickly tearing up a supply of food and swallowing it only partly chewed. Then they retired to the woods or hills or gathered in herds. The food was then brought back to the mouth in small



Some adaptations of the cow: teeth, hoof, stomach.



A good cow is a splendid animal. Her well-proportioned body, delicately featured head, large gentle eyes, fine horns, and sleek coat give her a beautiful appearance indeed.

quantities and thoroughly chewed. The cow has four stomachs. The first is really a large compartment in which food is stored when first swallowed. Then it is returned to the cow's mouth, and after being chewed passes to the third and fourth stomachs where it is digested. The four-compartment stomach is an adaptation which enables cattle to successfully overcome an unfavorable condition in their way of living.

We have learned how to use these adaptations of cattle for our own use. Cows of today are able to consume large amounts of feed and change it into large quantities of milk. Milk, as you know, is one of our most valuable foods.

Cows' *teeth* are specially fitted to eat grass or leaves of shrubs and trees. They have eight lower front teeth and a gristly pad opposite them in the upper jaw. Back of these is a bare space, then six grinding teeth on each side of each jaw. Have you ever listened to the ripping sound made by a cow as she feeds? She does not bite off the grass as a horse does, but pulls the grass into her mouth by means of her tongue, holds it firmly between the front teeth and upper pad, and by a sideways movement of her head tears it off.

The Horse: The horse is one of the noblest animals. He has long served man faithfully and well. There are few people who do not admire a high-spirited horse, with his well-proportioned body, sleek silky coat, and graceful movements.

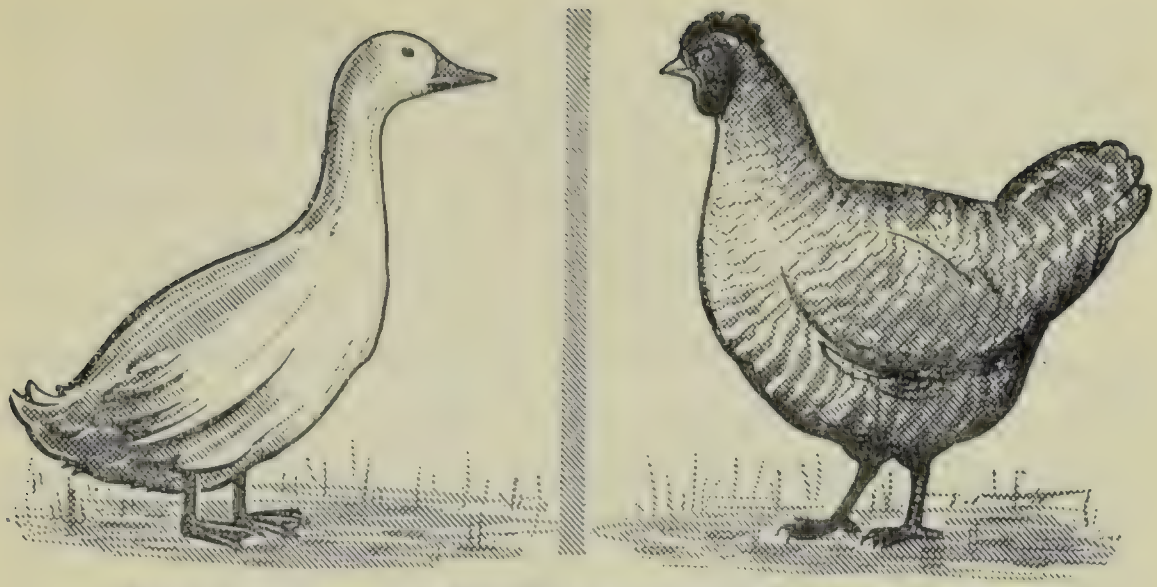
At attention! A good horse usually has a good head. His eyes will be large and widely spaced. His ears will indicate much about his character and state of mind. How has the horse helped man to do his work?

Horses were not always the tall splendid animals that they are at present. The first horses were not much larger than a rabbit and each of their feet had several toes. These little horses lived some millions of years ago when the surface of the earth was soft and damp. Their many-toed feet were the best kind for such conditions. As the surface of the earth became drier and more solid, horses gradually grew larger, their legs became longer, and one after another their toes disappeared until a single hoof was formed. The *single hoof* is well adapted for swift flight. It is also an excellent weapon of defence.

The *body* of a good horse is well muscled. His chest is broad and deep. The back of a horse useful for pulling heavy loads is short, but the back of a running horse is longer.

Do you know why a colt is born so long legged? The horse's method of escaping enemies is to take to flight. If a colt could not run quite rapidly soon after birth, he would be left behind as his mother and the other horses of the herd rushed away.

From Jungle Fowl to 350 Eggs a Year: When we sit down to a fine chicken dinner, we do not usually think very much of the great amount of study and work that has been necessary to develop the splendid poultry of the present. The term *poultry* refers to chickens, turkeys, ducks, geese and other birds raised for food and eggs. Chickens, of course, are the most widely raised. Do you know that our present-day breeds of chickens are supposed to have descended from the shy jungle fowl of India? Indeed there are still wild fowl in India that very closely resemble the present



Why are many of the characteristics of the duck so different from characteristics of the hen?

domestic birds. These jungle birds were rather small and did not have the plump "drum sticks" and the heavy layer of rich, white breast meat found on our modern poultry. They also laid very few eggs, probably not more than fifteen or twenty a year. Think of the great improvement that has been made. Some hens have laid over 350 eggs in a year, although all hens do not do so well.

The other kinds of domestic poultry (ducks, geese, turkeys, and others) have also probably been developed from ancestors that were once wild. The common duck of the barnyard and the wild mallard duck are so much alike that it is not hard to believe the domestic duck has been developed from wild ancestors.

The hen is probably the most valuable domestic bird. We value her not only for her meat-producing qualities but for her ability as an egg producer as well.

The Improvement of Domestic Animals

Many, many years ago, animals such as horses, dogs, chickens, and the others that man has tamed and taught to live with him, were wild. Man early learned that it was profitable to provide food, shelter, and protection for these animals in return for the work they could perform and the meat, milk, and eggs that could be obtained from them. The wild animal ancestors of our domestic animals did not produce as much meat and milk or as many eggs as the present-day animals do. During the many centuries since man first tamed and domesticated them, he has improved horses, cows, sheep, swine, and other animals very much.

Problems and Things To Do

1. In your own words, briefly tell about the battle for life in which all wild animals are continuously engaged. What happens to kinds of animals that are not fitted to successfully meet the conditions of their surroundings?

2. In some places, such as in large cities, many pupils have perhaps never seen a cow or a hen. It has been suggested that it is not important to know facts unless they are of some use. What do you think? What facts about domestic animals interest you? What information is important?

Select from the following, topics in which you are interested and feel are important for you to know. Look for more information. Discuss with your classmates.

(*a*) Discuss *adaptations* of cattle: chewing the cud, teeth.

(*b*) Why has man developed two types of cattle? Name the two types. Which is common in your locality?

Observe dairy cattle. Try to find the three wedges. Try to see that the body of the beef animal is like a large brick placed on edge, in other words rectangular. What are some of the other characteristics of good dairy and beef cattle?

(*c*) Tell in your own words, the story of the development of the little horse of early times into the horse of the present. Why was it important for the horse to become a very fast runner?

(*d*) Describe the body of a good draft horse useful for pulling loads. Of a racer. Of a horse that is a good runner.

(*e*) Why have colts such long legs at birth? Why does a colt often have to spread out its legs in order to eat grass from the ground? Why is the neck of a full-grown horse nearly as long as his legs?

(*f*) Look for stories that illustrate the faithfulness and the usefulness of the horse. Try to find stories of wild horses and of the little many-toed early horses. Bring good stories to school for your classmates to read.

(*g*) Observe poultry at home. Be prepared to tell about your observations at school. If home observations are not possible, try to arrange to keep a hen or a duck in a suitable cage at school. Be sure to provide suitable food and to keep the cage clean.

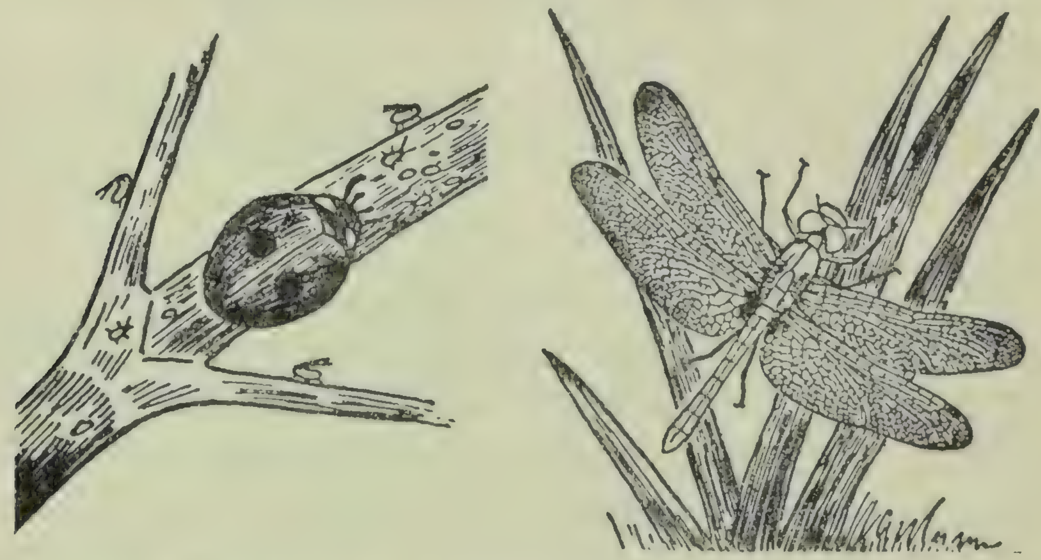
3. Tell in your own words a probable story of how man domesticated the cow, horse, hen, and other animals.

Our Valuable Insect Helpers

One author of this book once pointed out a *ladybird beetle* (or "ladybug" as it is often wrongly called) to a little friend whose name was Shirley. Immediately she cried, "Oh! Let me at it. I'll soon kill it." But the author was very glad to be able to explain that ladybirds helped us a very great deal and therefore should not be killed.

"What good are they?" asked Shirley. Let us answer this question. You will remember that tiny insects, known as aphids or plant lice, injure plants by boring into them and sucking the sap. These insects are the food of the ladybird beetles. Thus the more the ladybird beetles eat, the more they help to protect our plants from the aphids, and the more ladybird beetles there are the better. When Shirley understood this, she said, "I'll never kill another ladybird." You have very likely seen many ladybird beetles. They are small red-colored beetles with black spots.

"Buzz-buzz-buzz," sings the big, yellow-and-black *bumble bee,* and most people reply, "Go-away! We don't want you!" What they really should say is, "Sing away, bumble bee. Come back again soon." The bumble bee is another of our insect helpers. He will not bother you unless you interfere with him, and all day long he is working for the flowers in a very useful way. Each time he goes head-first deep into a flower as you have seen him do, his body is covered by a shower of golden colored pollen. Then, when he flies to another flower, he carries pollen with him. The transfer of pollen from one flower to another is a very important process in the production of the seeds of many plants. Thus the big, noisy bumble bee is performing very useful work for the flowers as he visits one after another. *Honey bees,* too, transfer pollen from flower to flower, and we also value them because of the honey they make from the nectar they gather from the flowers.



Two insect friends. A ladybird beetle feeding on plant lice (left). A dragon-fly aviator (right)—enemy of the mosquito.

Did you ever watch swift-flying *dragon-flies* darting here and there. They have been described as tiny airplanes, and are indeed graceful and beautiful creatures. Many stories have been told of the unpleasant things dragon-flies have done to people, but these stories are not true. You need never be afraid of dragon-flies, they will not harm you. They are really your friends. All day they hunt for mosquitoes. Would you not agree that insects which help us to destroy mosquitoes are not harmful but very useful?

Still Other Animals Are Useful

In spite of its warty appearance, the common *toad* is one of man's best friends. It eats harmful insects by the dozen. If you find a toad in your garden, you should protect it and try to encourage it to stay. It will help to keep harmful insects out of your garden. Do not be afraid that a toad will give you warts—it won't. It is a friend, not an enemy.

The toad can throw out his tongue, which is sticky, to catch an insect. In what way is the toad our friend?

Birds, too, wage war on harmful insects. They also eat bushels of injurious weed seeds. We should find it difficult indeed to keep harmful insects under control without the birds to help us.

The *garter snake* is not liked by many people. But it too is our helper. It eats mice and insects which damage the farmers' grain crops.

One of the animals most useful to man are the *earthworms.* Their good work as soil makers and improvers has been described on page 26. Look upon them as one of your best helpers.

Problems and Things To Do

1. Toads catch most of their food at night. What is their food? How do their food-getting activities help us?

2. List three ways in which the earthworm is man's assistant.

3. Are garter snakes harmful or useful? Give a reason for your answer.

4. Tell other people about the usefulness of the toad, garter snake, and earthworm.

5. Look for ladybird beetles and larvae on Manitoba maples, roses, caraganas, and other plants where there are often many aphids or plant lice.

Conservation

Later in this book is a chapter on *conservation.* Conservation means to protect and help useful wild animals and plants, and to use wisely our soil and forests.

What wild animals, that should be conserved, have been mentioned in this chapter? Why should they have our protection and help?

THE WEATHER, TODAY AND TOMORROW

Weather study and forecasting is a rapidly developing science that more and more affects large numbers of people and businesses.

No doubt you have had unpleasant experiences with weather—going to school on a bright morning and having to return in a whirling blizzard—planning a hike, picnic or ball game only to have it spoiled by rain. How useful it would have been to have known what kind of weather was coming! It is even more important in the following cases to have advance weather information:

Merchants selling ice cream and coal.

Power companies wanting to know how dark the next day will be to decide how much electricity will be used.

Farmers hoping for rain for their crops or for fine weather for harvest.

Truck companies transporting perishable goods.

Airplane pilots, fishermen, storekeepers, forest rangers, and many others.

In the spring and fall, people who have valuable flowers, fruits, or vegetables in their gardens can take steps to protect them if warned in time of approaching frost.

What is Weather?

Do you know exactly to what the word *weather* refers? We speak of stormy weather, cold weather, windy weather, and dry weather. What causes different kinds of weather? What causes wind? What makes rain?

To understand weather, the first thing to remember is this: When we use the word *weather,* we mean the *condition of the air at any particular time.* When the air is warm, we have warm weather. When the air is moving, we have windy weather. When conditions are such that clouds form, we have cloudy or rainy weather.

Look in a newspaper, or listen over the radio, for a weather report and forecast. What weather terms are mentioned? Some reports refer to:

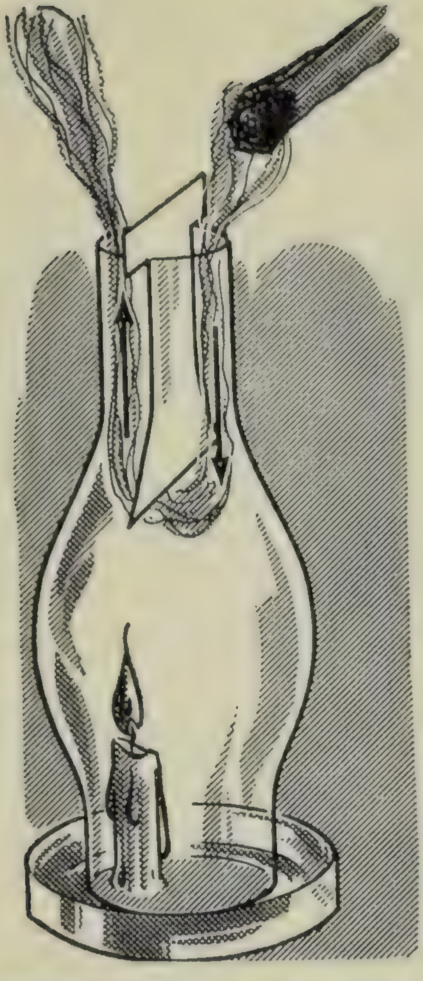
Temperature,
Speed and direction of the wind,
Sunshine or clouds,
Rain or snowfall, if any.

When these things are considered together, we have a picture of the weather at a particular time and place. There are many kinds of weather, and the weather often changes frequently and rapidly. It may be fair and warm in the morning, but cloudy and raining before night. Look out of the window now—describe under four headings the weather outdoors.

What Causes Wind?

Some days when we go out of doors, we feel the air pressing against us, we see trees and shrubs swaying in the wind, we see tumbleweeds and papers flying across the country before the breeze. When the air is moving, rushing from one place to another, we call it wind. What causes the wind? To find one cause, perform the following experiment:

1. (The teacher should carefully supervise this experiment as it involves fire.) Insert a cardboard partition into the top of



a lamp chimney as shown in the diagram at the left. This can be done by a little careful planning and bending of the cardboard. Arrange the apparatus as illustrated. The candle should be standing in about one-quarter inch of water. Be sure, also, that the candle is placed *to one side* of the partition. Hold a smoldering roll of paper or cloth (1) above the side of the partition above the lighted candle, and (2) above the side of the partition opposite to the candle. Watch the smoke.

On which side of the partition will the air be warmer? On which side cooler? On which side of the partition does the smoke indicate that the air is rising? On which side falling?

2. Drop small bits of fluffy cotton batting, pieces of paper etc., over a warm radiator. Is the warm air above the radiator rising or falling? Try to answer before reading further.

Air expands when it is heated and becomes lighter. When air is cooled, it shrinks or contracts and becomes heavier. Heat from the sun warms the earth which in turn warms the air above it. Not all parts of the earth heat equally. There are areas above which the air is warm, and other areas above which the air is cold. There are times when the cold, heavier air pushes over into the areas where the air is warm and lighter. Air thus in motion is known as wind. Winds vary from almost calm or gentle to strong destructive gales or hurricanes. Winds may cause changes in temperature, bring rain or snow, or produce other important changes in the weather.

The speed of the wind is recorded in miles per hour. Winds are known by the direction from which they come. A wind from the south is a south wind.

Humidity

Water is continually changing from its liquid form and passing into the air in the form of a gas called *water vapor*. We say it *evaporates*. Clothes on a line become dry. Water evaporates from large and small bodies of water.

EXPERIMENT: Fill a dry, thin glass tumbler or shiny tin can with ice cold water. Allow it to stand for a few minutes. Then consider the following:

(a) Could the moisture that collected on the outside have come through the glass? If not, from where did it come?

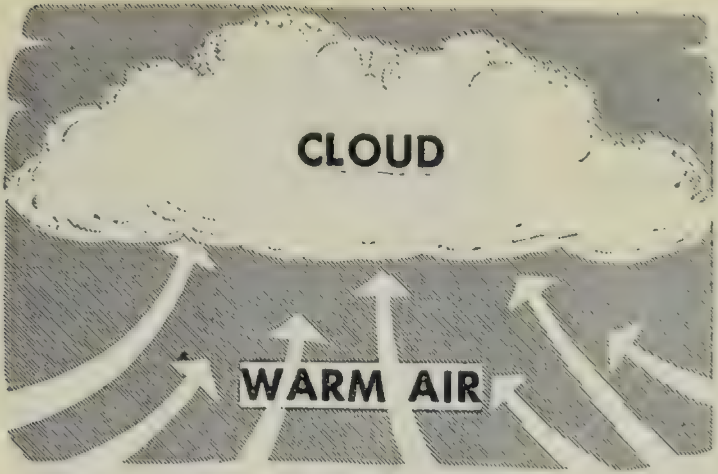
(b) What change in the air immediately around the tumbler caused it to give up its moisture?

In our experiment we note that as the air next to the tumbler becomes cool, the water vapor in it *condenses*, that is, it changes into liquid water. The water is deposited on the outside of the tumbler. As the air cooled, it could not hold all the water in it. Warm air can hold more water than cold air.

The term *humidity* refers to the amount of moisture in the air.

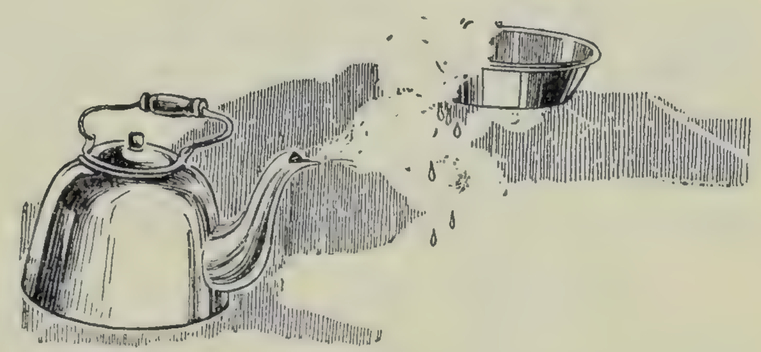
Clouds, Fog, Rain, Snow, Hail

When air becomes warm it expands and becomes lighter. Warm, moist air is often forced upward above the earth. As it rises, it is cooled. The moisture in it condenses into millions of tiny droplets. These tiny drops are so light in weight they float in the air and form *clouds* (high in the air) and *fog* (at the surface



How a cloud is formed. There is moisture in the warm air and moisture in the cloud. Explain what change has taken place to form the cloud.

of the earth). The white cloud at the mouth of a boiling tea-kettle and the little cloud visible on a cold day when you can "see your breath" are formed by condensation. Explain what takes place in each case.

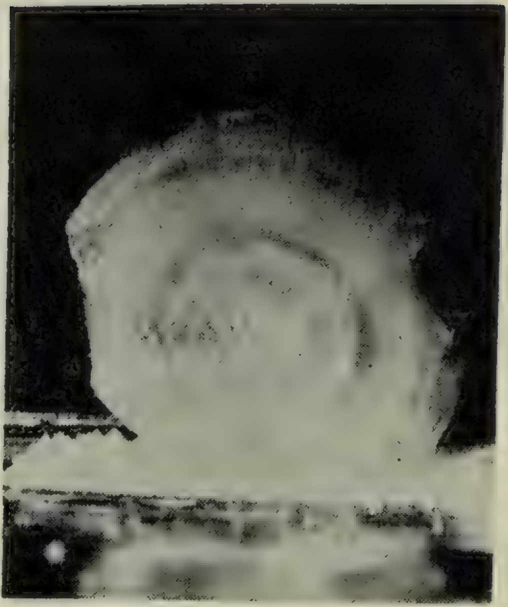


You can "make rain" by holding a *cold* pan or plate in the "cloud" at the mouth of a steaming teakettle.

The droplets of water in a cloud may grow larger as more water vapor in it condenses. Finally they are so large and heavy they can no longer float in the air, and fall to the earth as *rain.*

Snow is not frozen rain. If the temperature is below freezing, snowflakes form instead of rain when the air above the earth is cooled so that it gives up its moisture. Bit by bit, the snowflakes are built up until they fall to the earth.

A very hot day during the summer may be followed by a severe *hail* storm. In this case, when the water vapor in the air is changed to rain-drops, the rain-drops are carried rapidly upward to a layer of air where it is very cold. Here, they are frozen into tiny balls of cloudy ice or hailstones. The hailstones begin to fall toward the earth, until they reach a warmer place in the air. Here they may gather more moisture. But another rush of upward-moving air catches them and whirls them again up to the freezing layer of air. The moisture around the hailstones freezes, thus adding another layer of ice around each of them. Some hailstones may be hurled up and down many times. Finally they fall to the earth.



A photograph of a hailstone showing the circular layers of snow and ice of which it is made. (U.S. Weather Bureau photo.)

On warm, moist summer afternoons when the air near the earth is much warmer than the air higher up, the warm air may rise rapidly. As a result a cloud producing a *thunderstorm* is formed. As you know,

Dew on plants. From where did it come? How is it formed? (U.S. weather Bureau photo, W. A. Bentley.)

lightning, thunder, and rain are parts of a thunderstorm.

Dew and Frost

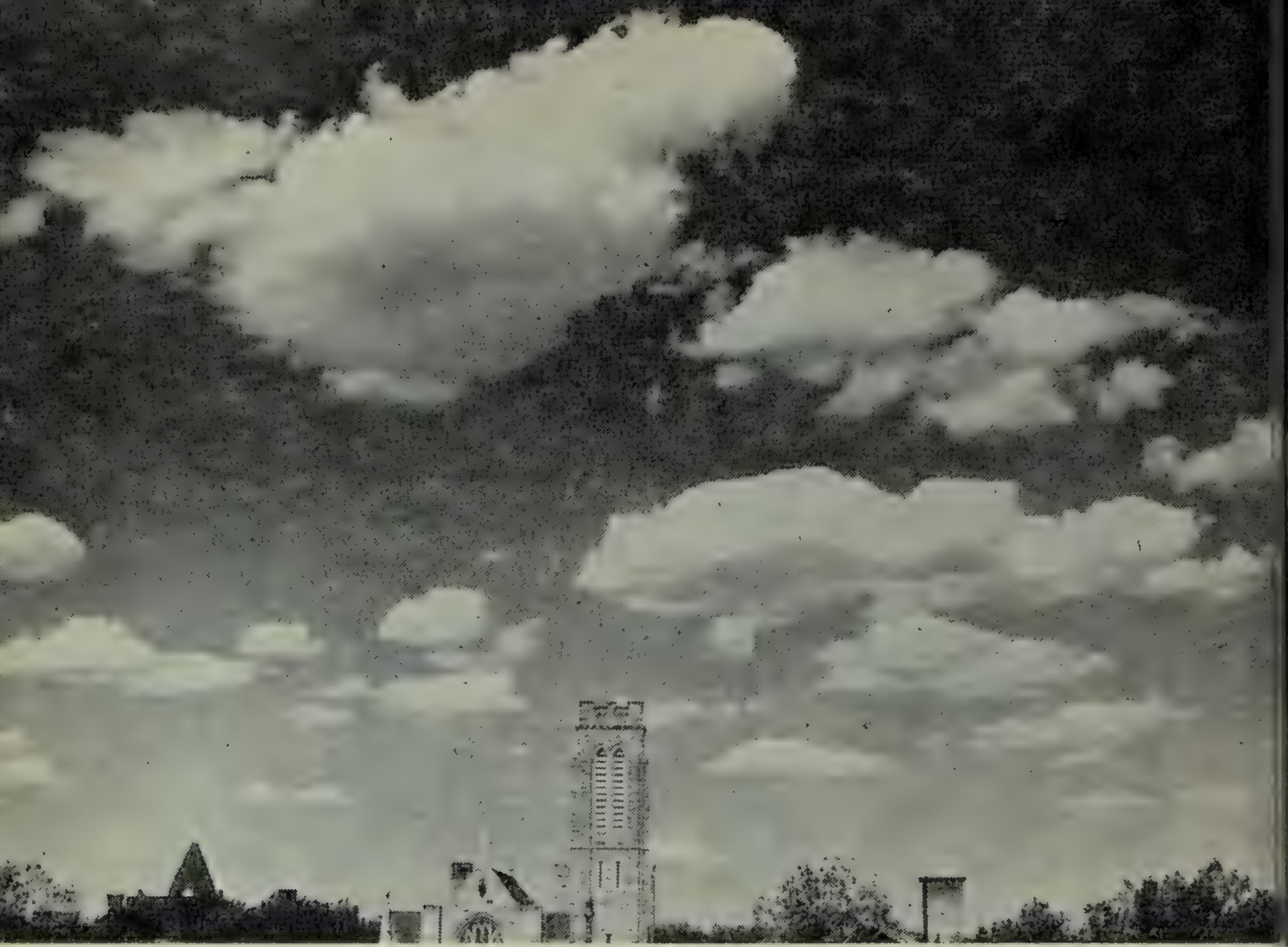
It is wrong to say, "A heavy *dew* fell," because dew does not fall. The dew that you find on the grass in the morning did not fall as rain does. It formed just where you find it. At night the earth and objects on it become cooler than the air. When the air touches a cool object, some of the water vapor in the air changes to water drops on the object. This moisture we call dew. (See experiment on page 50.)

Frost is not frozen dew but is formed in much the same way. When the temperature is below freezing, the water vapor in the air is changed to tiny ice crystals on objects instead of becoming drops of water.

Fair Weather and Storm Clouds

We have learned that clouds are formed of tiny droplets of water. Clouds tell much about the condition of the air at different levels above the earth. There are many kinds of clouds and scientists have given them names. Watch the sky for clouds like the following and learn to call them by name: (See experiment on page 51.)

Cumulus clouds are woolly-appearing, dome-shaped, and have flat bases. They are usually about a mile above the earth. When cumulus clouds are between you and the sun, they will appear dark with white edges. When you are between the sun and the cumulus clouds, they will be white. These clouds usually indicate dry, fair weather, although they may give rise to thunderstorms on a summer afternoon when the air is warm and moist.



Cumulus clouds of fair weather. Note the flat bases and rounded tops. (U.S. Weather Bureau photo, H. T. Floreen.)

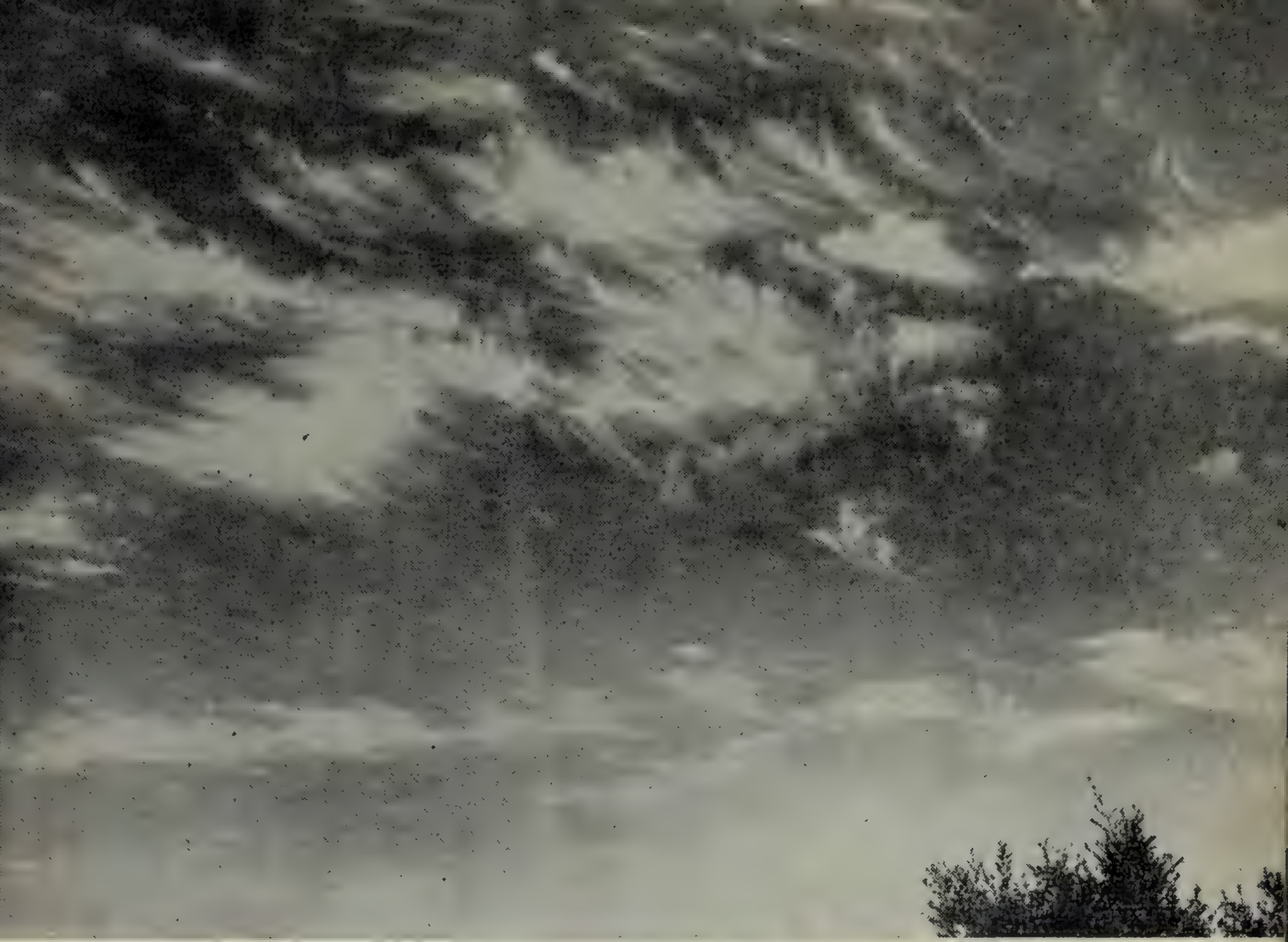
Cirrus clouds are very high (five or six miles) white feathery clouds composed of ice crystals. If the sky behind them is blue, cirrus clouds usually indicate fair weather. Otherwise, they forecast rain in one or two days.

Stratus clouds are in layers. They are dark and may indicate an approaching storm. Sometimes stratus clouds may be very near the ground, forming fog.

Nimbo-stratus clouds are dark, shapeless clouds with ragged edges from which steady rain or snow usually falls. They may be very low.

Problems and Things To Do

1. Make a list of the ways in which weather affects our daily activities.



Cirrus clouds. Are these high or low clouds? What do they tell about the weather? (U.S. Weather Bureau photo, F. Ellerman.)

2. Why are weather forecasts valuable to: aviators, fishermen, gardeners, other people?

3. What is weather? What items about the weather do weather reports usually include?

4. Draw a diagram to illustrate an experiment to learn one cause of wind. Label your diagram fully to show one way movements of air, called winds, are set up.

5. Upon what does the power of the air to hold moisture depend? What do we call water when it is a gas in the air?

6. As air is pushed upwards above the earth what causes it to give up its moisture? What is formed as the moisture in the air is changed to tiny droplets?

7. How can you show, experimentally, how rain is formed?

8. Explain the difference in the way snow and rain are formed. Examine some snowflakes as they fall on a dark, cold surface. All perfect snowflakes have six points, but no two are exactly alike.

9. What takes place in the air to form hailstones? If you can, sometime, break a hailstone in two and look for the rings of ice in it.

10. Look for pictures of clouds. Arrange them on two pages in your science book, one marked *fair weather clouds*, and the other marked *storm clouds*. You can collect a set of beautiful pictures.

11. From day to day, try to recognize cumulus, cirrus, and other kinds of clouds as they appear in the sky.

12. Describe an experiment to learn how dew is formed. Why is it wrong to speak about dew falling? Under what condition does frost form instead of dew?

Signs to Foretell the Weather

Will it rain tomorrow? Will it be windy? Will it be warmer or colder? It would be interesting and often quite valuable to know today the kind of weather to expect tomorrow. Do you know of some of the commonly referred-to weather signs? Some weather signs do give an indication, more or less reliable, of the approach of fair or stormy weather. Often so-called weather signs are useless and foolish.

By making observations of your own for several months, try to find out which of the following weather signs can be depended upon. You will need to observe very carefully. Keep a record.

1. Dark clouds hiding the sun at sunset foretell rain.

2. A clear sky at sunset indicates that the following day will be fair.

The men are releasing a pilot balloon which they will watch to learn about air currents at high levels. (Meteorological Division, Toronto, photo.)

3. A ring around the moon or the sun is a sign of a coming storm.

4. Heavy coats of fur on animals in the fall foretell a cold winter.

5. When the wild geese fly south early, an early winter is indicated.

6. "Rainbow at morning, sailors take warning. Rainbow at night, sailors' delight."

7. Rain is coming when the smoke falls to the ground.

8. The appearance of the clouds indicates coming weather conditions.

9. When a crescent moon will hold water, the weather will be dry. A crescent moon that cannot hold water foretells wet weather.

10. "Rain before seven, clear before eleven."

Signs 4 and 5 are not to be depended upon. Men who have made an accurate study of weather state that we cannot accurately foretell the weather by observations of animals. It is true that the smoke curls low in damp weather, but it is doubtful if sign Number 7 can be relied upon to indicate the coming of rain. The moon does not affect weather conditions on the earth, therefore sign Number 9 is of no value in foretelling weather changes.

The appearance of the sky at sunset, as suggested by 1 and 2 may or may not indicate the weather to be expected the following day. A ring around the moon or the sun is produced by the action of light on particles of water or ice in the air, therefore sign Number 3 has some value as an indication of an approaching storm. Signs 6 and 10 are very often true, because they result from conditions which do affect the weather. But we must be sure of a sign before we depend upon it.

Air Pressure

It can be shown that air is a real substance and has weight. Since it has weight, it presses down on all objects below it (about 15 pounds on every square inch). Sometimes the pressure of air is greater; sometimes it is less. The parts of the country in which the air pressure is less are known as *low pressure areas*. Regions where the air pressure is greater are *high pressure areas*

How Scientists Forecast the Weather

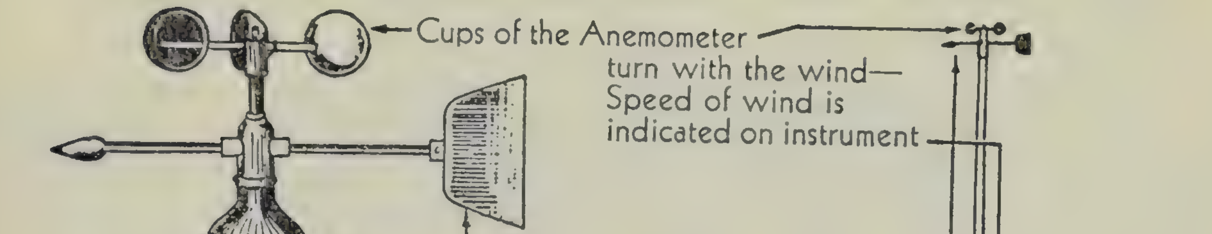
(*What kind of weather can we expect tomorrow?*)

You may have heard over the radio a weather forecast such as—Saskatchewan: Mostly fair and warm, possibly light scattered showers. Manitoba: Strong northerly winds, colder. Southern Ontario: Fair and continued cool, with higher afternoon temperatures.

How do the "weather men" make forecasts?

At many places in Canada and the United States are *weather stations*. Some stations are in the far north. Ships at sea provide information. At each station are instruments for recording various things about the weather, such as:

Temperature at different times of the day,
Pressure of the air at different times of the day,
Speed and direction of the wind,
Amount of rain or snow that falls during the day,
Hours of sunshine.

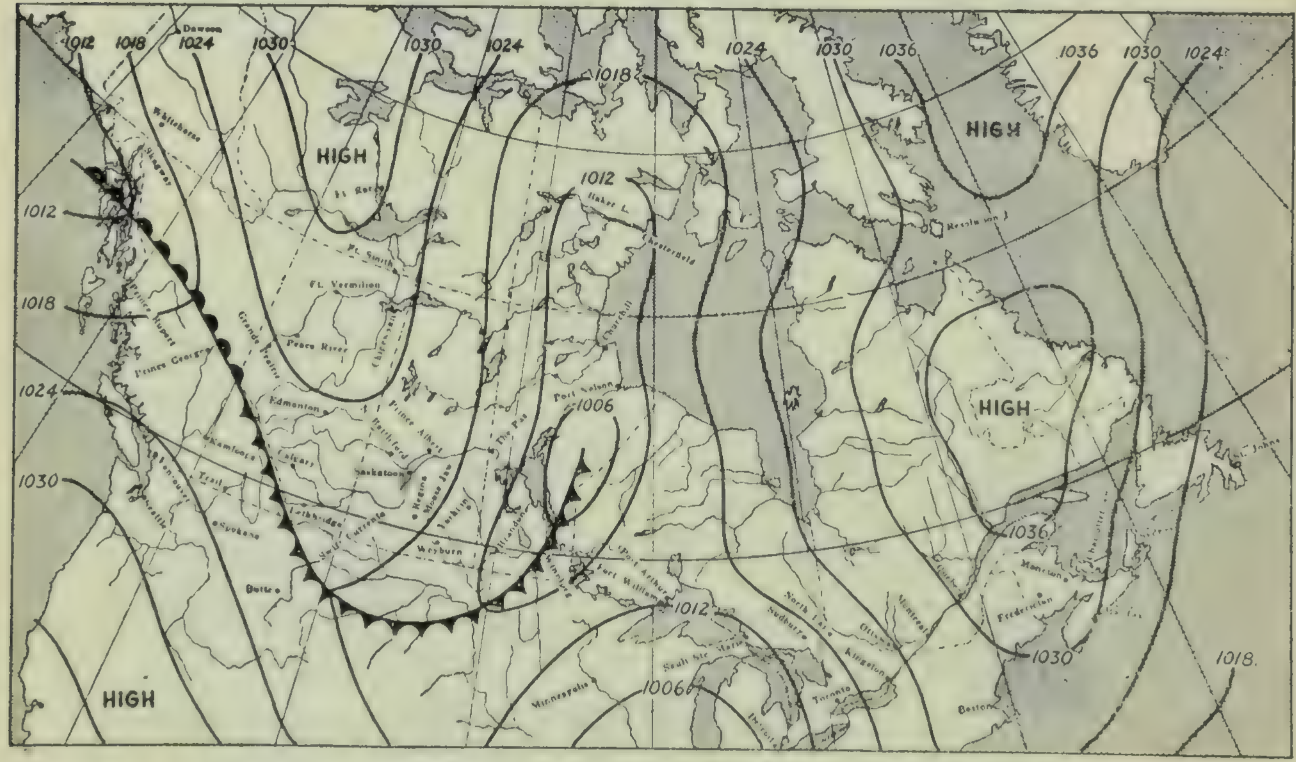

Cups of the Anemometer turn with the wind— Speed of wind is indicated on instrument
Weather Vane— tells direction of wind
Inside View of Rain Gauge
Wooden Screen— with slatted sides containing thermometer

A weather station. Note the various instruments and where they are located. The instruments at the left are enlarged to show you more about them.

Trained *weather observers* are in charge of the weather stations. These men take the readings of the instruments at the same time every six hours, and immediately send the information by telegraph to weather offices located at such places as Toronto or Winnipeg. In these offices are the men who make the weather forecast. Here the information received from the weather stations is marked on a large map. When completed, this *weather map* gives a picture of the weather for all of Canada.

The first step in forecasting weather is the preparation of the weather map.

Parts of the country where the air pressure is low as well as areas where the air pressure is high are marked on the map. This information is important, as winds blow in great circular movements and clock-

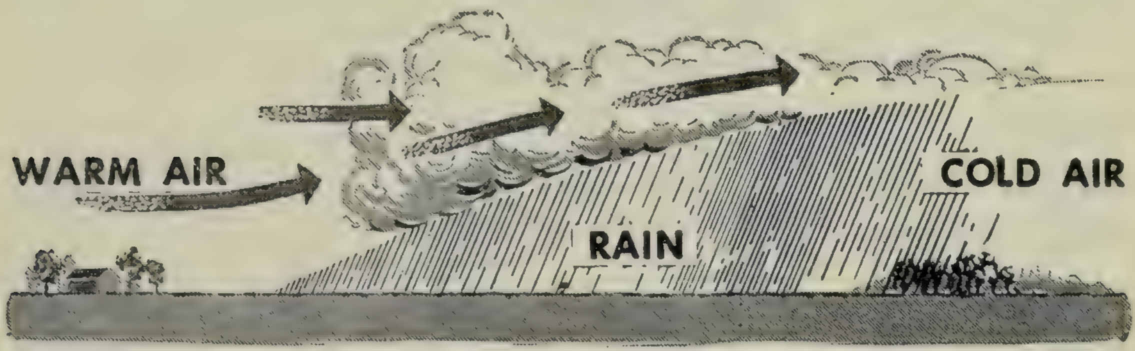


This weather map shows areas of high and low air pressure on a certain day. It also shows the front of a cold air mass moving southward (see the line of little black triangles) and a movement of warm air travelling eastward (see the line of small black half-circles). (Canadian Meteorological Division Map.)

wise out from areas of high pressure, and anti-clockwise into areas of low air pressure.

The location and movements of great air masses are also marked on the weather map. What is an air mass? It is a large quantity of air that has remained stationary over an area for a long time. An air mass that has been lying still in the far north Arctic region will become very cold and dry. But an air mass that has stood for days over the Gulf of Mexico region will be warm and moist. Finally, these air masses begin to move. As they flow along they may cause changes in the weather.

Suppose we have been having warm, cloudy weather. Then a cold air mass from the Arctic flows into our area. It is not difficult to see that our weather will become cold and dry. Similarly, when a warm, moist air mass passes over our home area our weather becomes warm and moist. When an air mass of one kind meets or overtakes an air mass of another kind, important weather changes occur.



This diagram shows how a warm air mass may overtake a cold air mass and be forced upward causing rain or snow depending upon the season of the year.

An air mass may be several hundreds of miles wide and may cover thousands of square miles. When cold and warm air masses meet, they do not mix readily.

The edge of a moving air mass or the surface separating two air masses is known as a *front*. Air masses and fronts are marked on the weather map.

Weather observers use several instruments to gather information: Thermometers, rain gauges, instruments and small balloons that tell wind speed and direction, barometers which measure air pressure.

This is a photo of a *radiosonde*. In the box at the lower end are instruments to gather weather information at high levels. A helium-filled balloon carries the box of instruments upward and finally explodes. On the way up a radio transmitter sends messages back to the observer. A parachute lowers the radiosonde to the ground. Then the weather records made by the instruments are examined.

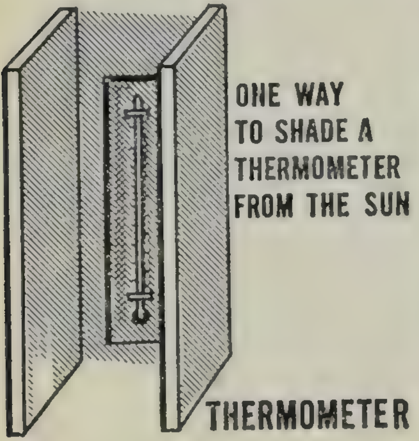
The men responsible for forecasting the weather carefully examine each newly made weather map and compare it with previous maps. They can tell how areas of high and low air pressure are moving. They can tell where air masses are located and the direction and speed in which they are moving, as well as the kinds of weather they are producing. Knowing the kind of weather in one place and also how weather conditions are changing, the forecasters can tell what is likely to happen before long in another place several hundred miles away. They can say for each area whether it will rain and when the rain will start and stop. They can tell whether it will be warm or cool, and whether it will be windy or calm.

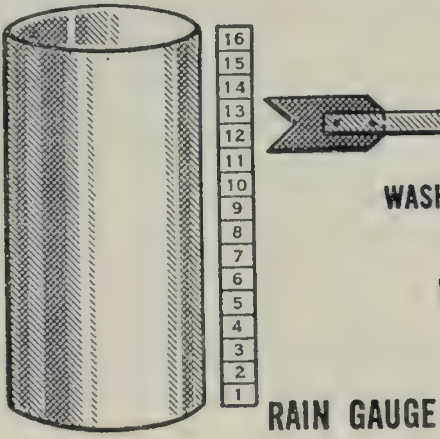
Many years of scientific study and practice enable weather forecasters to be right a very large part of the time.

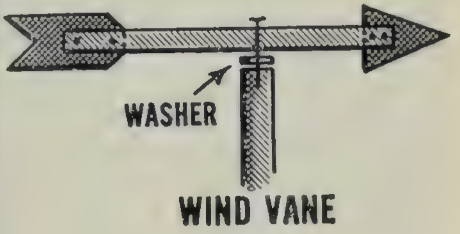
Questions and Things To Do

1. How reliable are weather signs? List several signs that cannot be depended upon. List several that may indicate coming weather fairly accurately.

2. Establish a weather station at your school and keep records of the weather. Use a straight-sided tin can as a rain gauge and place it well in the open. Use a ruler to measure the rain that is caught in your gauge. Construct an arrow-weather-vane to indicate wind direction. You will not have sufficient information to do much weather forecasting, but you can learn many interesting things about about the weather and its ways.







3. Most daily papers publish weather forecasts. Look for the forecast each day and keep a record for a time of the forecast and the actual weather. How many forecasts are correct?

4. What weather information is recorded at weather stations? Where are weather stations located?

5. Where are weather forecast offices in Canada? How is weather information sent in from weather stations?

6. In what form is the weather information recorded in the weather office?

7. What is an area of *high pressure*? an area of *low pressure?*

8. How do winds blow around a low pressure area? A high pressure area?

9. What change in the weather occurs when a cold air mass reaches an area? A flow of warm, moist air?

10. How does the weather forecaster decide beforehand what kind of weather may be expected in a certain area?

11. If there is a weather station near your school, try to visit it. Ask the observer to explain the various instruments to you.

The Scientific way

The information dealt with in some sections of your science book is perhaps not too easy to understand.

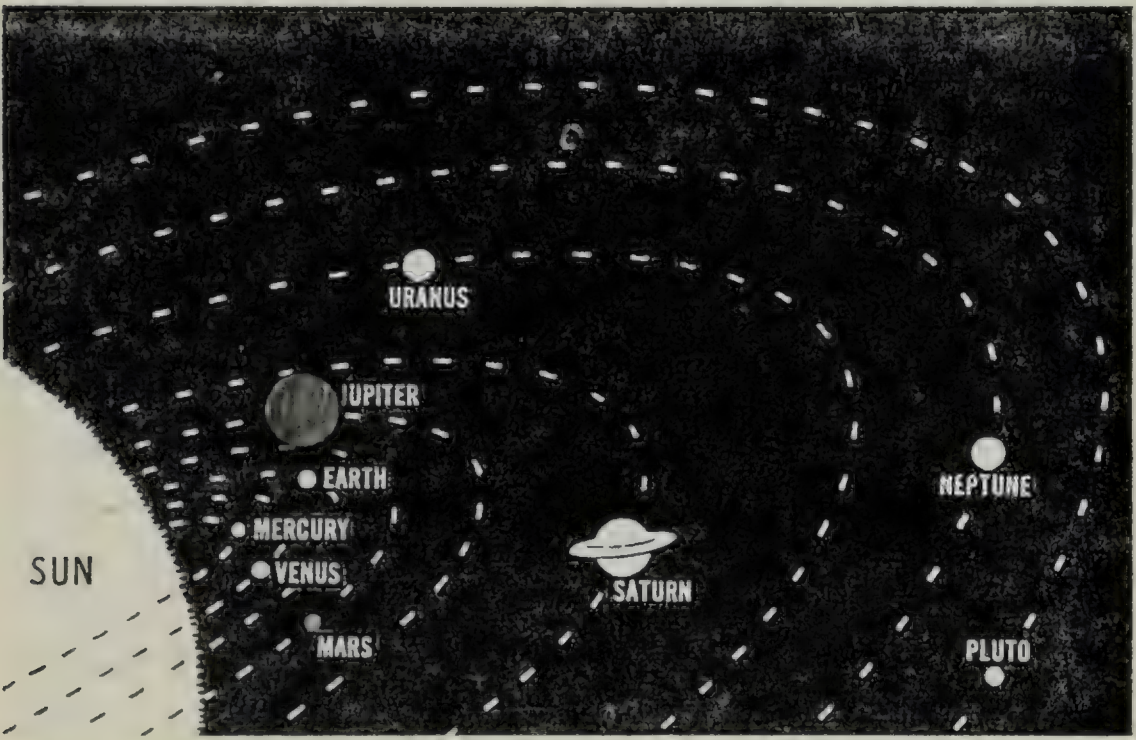
It will be necessary for you to:

(a) read carefully in several science books.
(b) discuss each item carefully with your classmates.
(c) do the things suggested for you to do.
(d) think carefully as you work and read and discuss.

This is the scientific way to study—find out *all* you can about each topic, and be sure you understand it thoroughly.

THE PLANET FAMILY

Sometimes, on a clear night, when you look up into the sky, it seems to be full of stars. And so it is. But there are more than stars to be seen on many nights. Other heavenly bodies, called *planets*, are often visible. These planets revolve around the sun in the same way that the earth does. In fact, the earth is one of the planets. The planets appear in the sky as very bright stars, but they shine with a steady light and do not twinkle as the stars do. We see the stars by their own light, but the planets are visible to us by light from the sun. At night, although the sun may be on the other side of the earth, it is, nevertheless, so large that it shines on the planets and lights them up so that they can be seen from the earth. The planets



This diagram will show you how the planets revolve around the sun. It also indicates something of the size of the planets.

are dark and cold when they are not receiving light and heat from the sun.

Scientists have studied the planets for a long time. They are not sure whether there is life on any of them except, of course, the earth.

What is the Solar System?

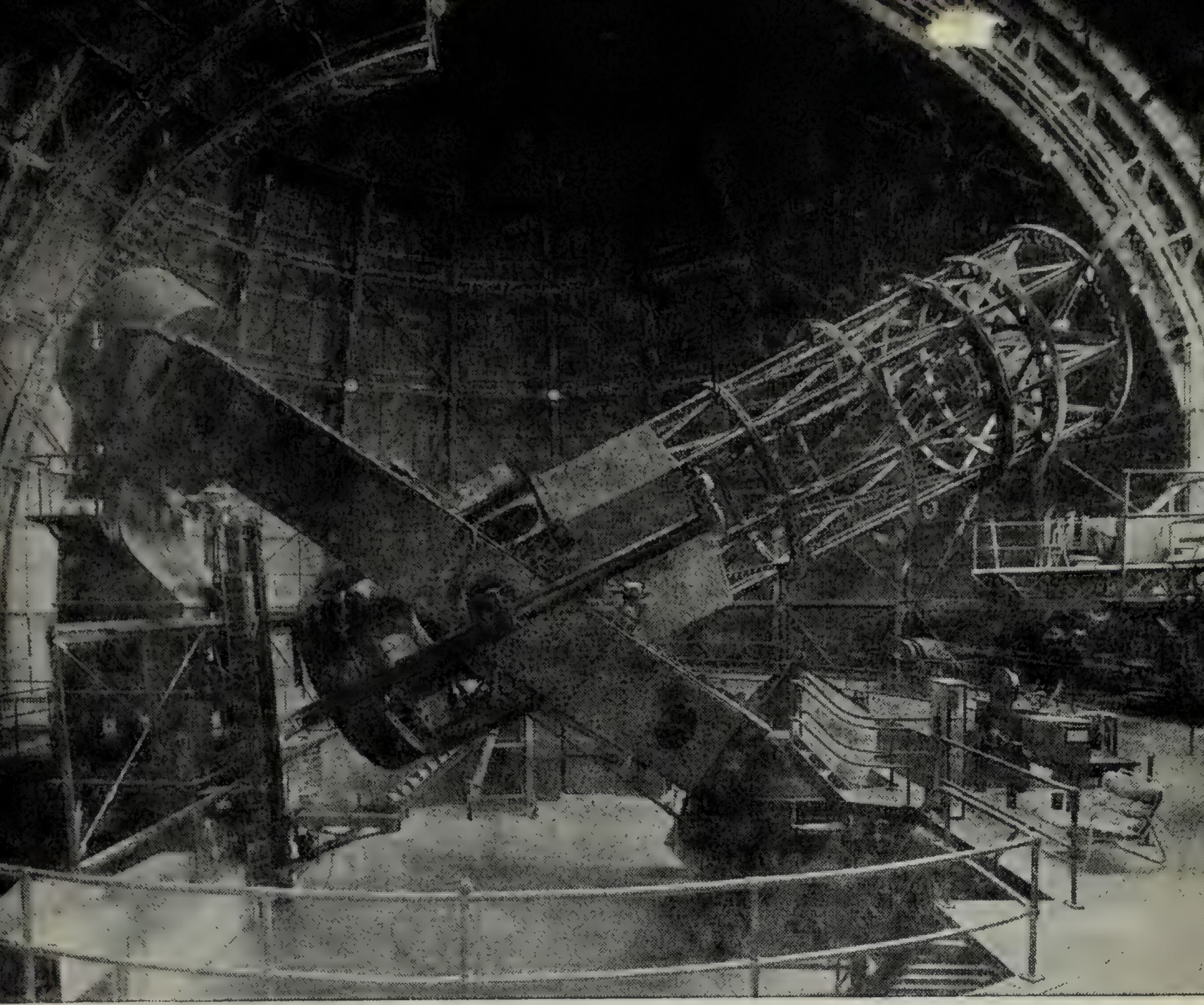
The scientific name of the Planet Family is the *Solar System.*

Including the earth, there are *nine* planets travelling around the sun. Two of the planets are nearer to the sun than the earth is, and six are farther away. In the order of their distance from the sun, they are: *Mercury*, *Venus*, *Earth*, *Mars*, *Jupiter*, *Saturn*, *Uranus*, *Neptune*, and *Pluto.* Each planet travels around the sun in a nearly circular path known as its orbit. The time required for each planet to travel once around the sun is known as its year. The farther a planet is from the sun, the longer is its year. All the planets travel in the same direction and since each has its own path there is no possibility of them colliding with each other. Most of the planets, including the earth, have one or more moons. Each of the moons travels around its own planet in its own orbit.

What holds the planets in their orbits? As each planet whirls around the sun, a force is produced that would throw the planet farther out into space. However, another force, called gravity, pulls each planet toward the sun. As the two forces are equal, each planet follows the same path or orbit year after year.

The Members of the Solar Family

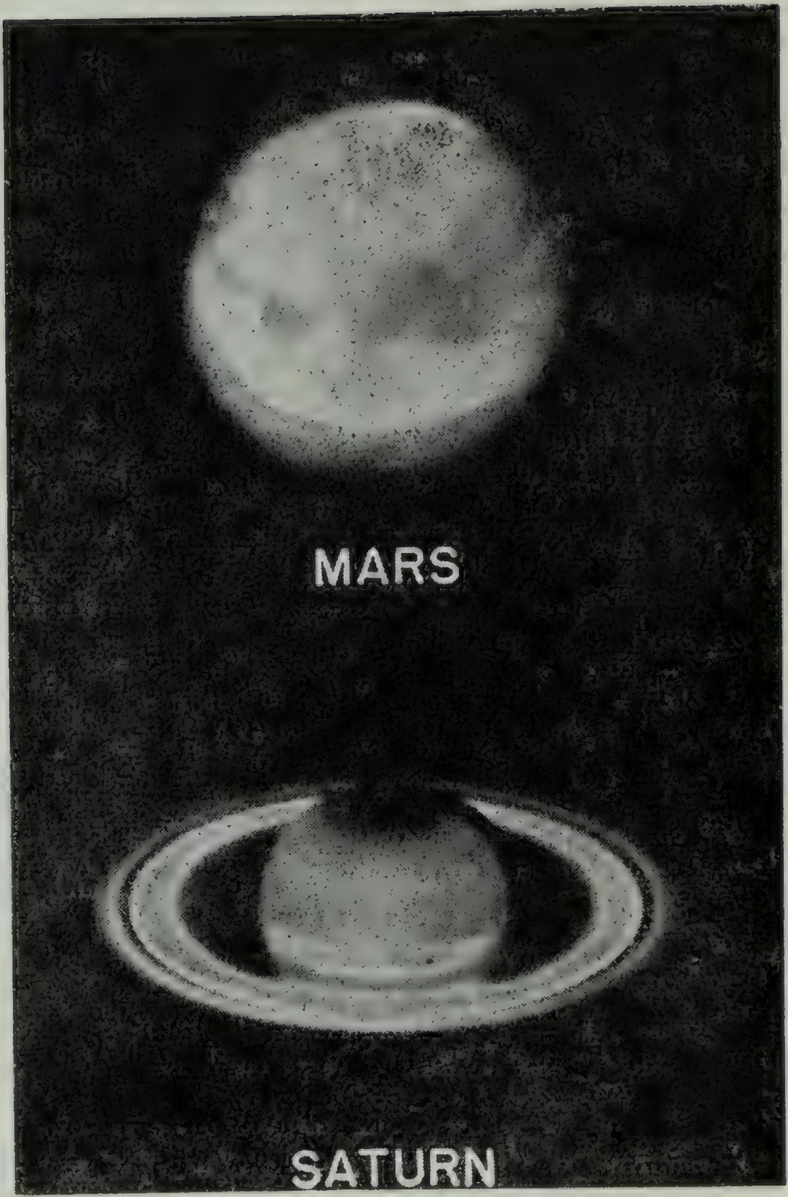
How many planets are there in the sun's family? Try to name them in the order of their distance from the sun.



By means of great telescopes, such as this one, scientists can observe the planets and other heavenly bodies. Notice the chair and desk at the lower right hand corner. (Mount Wilson Observatory photo.)

The smallest of the sun's family and the planet closest to the sun is *Mercury*. In the old legends Mercury was the swift messenger of the gods. It is easy then to understand why the swiftest moving of the planets should be called Mercury. Mercury is much smaller than the earth and it has no moon. It is so close to the sun that it is difficult to see except just after sunset or just before sunrise. Because of this, it is often called the morning or evening star. We know, of course, that it really is not a star.

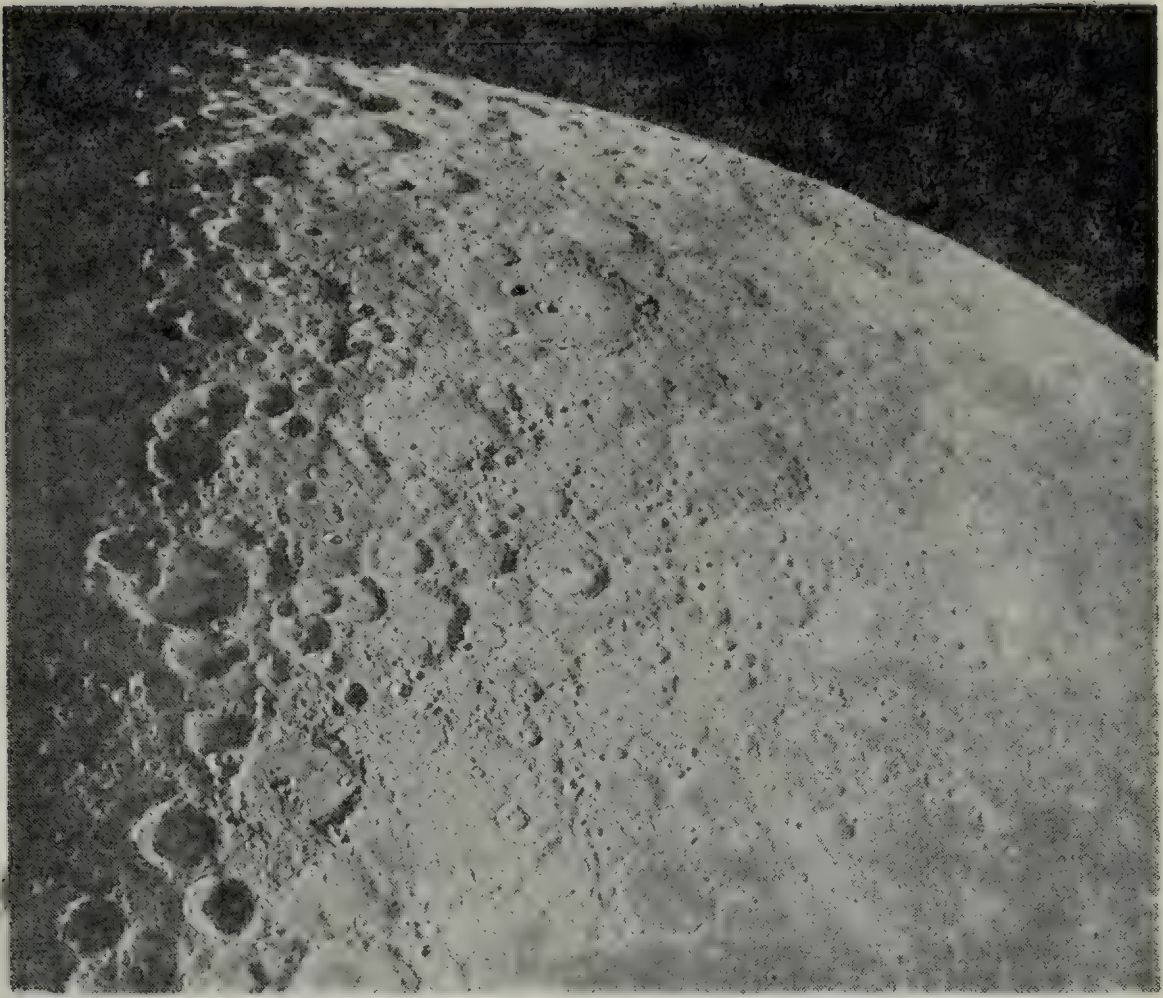
Venus is next to Mercury from the sun. It is only a little smaller than the earth but like Mercury it has no moon. It is the brightest and most beautiful of all the planets and so was named Venus after the ancient goddess of beauty. Venus is also known as the evening or morning star. You should be able to see it at certain times of the year in the western sky just after sunset.



These photographs of Mars and Saturn were taken with the telescope shown on page 67 (Mt. Wilson Observ. photo.)

The planet we know most about is the *Earth* upon which we live. The earth is about 93,000,000 miles from the sun. Its year is 365¼ days, during which it travels an orbit of 580,000,000 miles. The earth has one moon which is described on pages 70-72.

Mars has a reddish color as we see it in the night sky. The Romans named this planet after Mars, their god of war, because the red color seemed to represent war and bloodshed. We know much more



The craters and mountains on a part of the surface of the moon, as seen through a telescope. (Mount Wilson Observatory photo.)

about Mars than we know about any other planet, except the earth. We can see its two small moons, and we know it is the fourth planet from the sun. A year on Mars is about twice as long as an Earth year. Since there is oxygen on this planet there could also be life.

Jupiter is the fifth planet in distance from the sun. It has eleven moons and is larger than all the other planets rolled into one. You might say it is the king of the planets. The ancient people thought so anyway for they named it Jupiter after the king of their gods. Jupiter is almost as bright as Venus.

Between the orbits of Jupiter and Mars, travel smaller bodies called *asteroids*. They are about 1,500 in number and are very small, most being less than sixty miles in diameter. They travel around the sun and are therefore members of the solar family.

You would always remember what *Saturn* looks like if you were fortunate enough to see it through a telescope. It is a wonderful sight. It is different from the other planets because it has rings circling it. The rings are thin and flat and consist of small particles that reflect the light of the sun just as Saturn itself does. In addition to its rings Saturn has nine moons.

The six planets about which we have now learned have been known for over 3,000 years. The other three were discovered in the last 200 years. *Uranus* is very hard to see because it is so far away. It has four moons. It must be very cold because it is nineteen times as far from the sun as the earth is.

Neptune is still farther away from the sun than Uranus. It is almost as large as Uranus. We must use a telescope to see Neptune.

Pluto is the last planet of which we know today. It was not discovered until 1930. It is thirty-nine times as far away from the sun as our earth is. The length of its year is equal to 248 earth years.

What is the Moon?

How dark the night is when the moon is not shining! And how bright and silvery everything appears in the beautiful, clear light of the full moon! We think it strange that all that sparkling light comes from a body that has no light of its own. The moon simply reflects back to us the light it receives from the sun.

Scientists tell us that the moon may be a piece of the earth that broke away millions of years ago. Ever since then, it has been travelling around the earth in its own orbit. It is kept in place by the attraction of the earth.

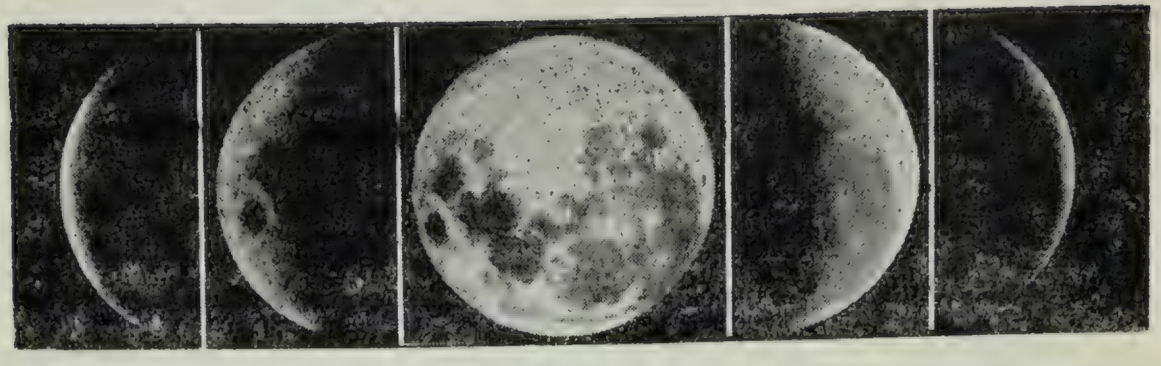
Even with a small telescope we can see the moon quite well. We can see only one side but we think that the other side must be quite similar to the one we can see. We notice high, steep mountains, vast craters, and wide, level plains. There is neither water nor air on the moon, however, so there can be no plants or animals. (See photograph of the moon on page 69.)

The Phases of the Moon

Can you think of all the different shapes of the moon you have seen? Sometimes the moon appears like a thin crescent. We call that shape a crescent moon. At other times we see half the moon. Some times we see the full round face of the moon.

The moon takes about a month to complete one journey around the earth. As it travels in its orbit it is constantly changing its position, so that sometimes more of the part lighted by the sun can be seen than at other times.

Look at a calendar and find when the next new moon is to appear. Make observations of the appearance of the moon from that date until the date of the following new moon. Draw neatly on a piece of paper the various shapes you see. You will notice that every night after the new moon, more and more of the lighted surface of the moon can be seen. Finally you will see



Photographs showing the phases of the moon: a new crescent moon at the right, and the full moon in the centre. The photographs were taken with the telescope shown on page 67. (Mount Wilson Observatory photo)

half of the lighted surface of the moon! This is really one-quarter of the whole surface of the moon so we call it the first quarter. Be faithful in your observations and you will soon be rewarded with a view of the full moon. How long after the new moon does the full moon appear? When it is full, the moon is on the side of the earth away from the sun. It then begins its journey back towards the sun. As it does so, we notice the moon rises later each night, and we see less and less of the lighted part. Soon we notice that it is once more back to quarter size. This is called the last quarter. Finally it disappears and we see no moon for a time.

Shortly, however, the crescent shape of the next new moon reappears in the west.

We have a name for these monthly changes in the apparent shape of the moon. They are known as the *phases of the moon.*

Shooting Stars—Meteors

How many shooting stars have you seen in one night? Scientists tell us that millions of them fall towards the earth every day. They are not really stars, but should be called *meteors*. Meteors are just pieces of rock-like material. Some weigh several tons but most of them are no larger than a walnut.

The meteors are part of the solar system. Each one revolves around the sun in an orbit of its own. Sometimes, however, the orbit of a meteor may cross the orbit of the earth, and then the attraction of the earth will pull the meteor to it. We do not see the meteors until they enter the earth's atmosphere. Then, because they rub against the atmosphere they will become so heated that they give off light and usually burn up, forming dust or vapor.

Sometimes a meteor is so large it goes right through the atmosphere and strikes the earth. It is then called a meteorite. You may perhaps see a meteorite if you visit a museum.

Questions and Things To Do

1. Which planet is farthest from the sun? Which is nearest?

2. Name the smallest planet.

3. What body is the centre of the solar system? How many planets are there?

4. Why can we see the planets?

5. Draw a diagram of the sun, Mars, and the earth as in the illustration on page 65. Draw a line from the sun to Mars and from Mars to the earth. This line will represent light from the sun striking Mars and being reflected to the earth and will show you how we see the planets by reflected light. How do we see the moon?

6. In what ways are all planets alike? What is an orbit?

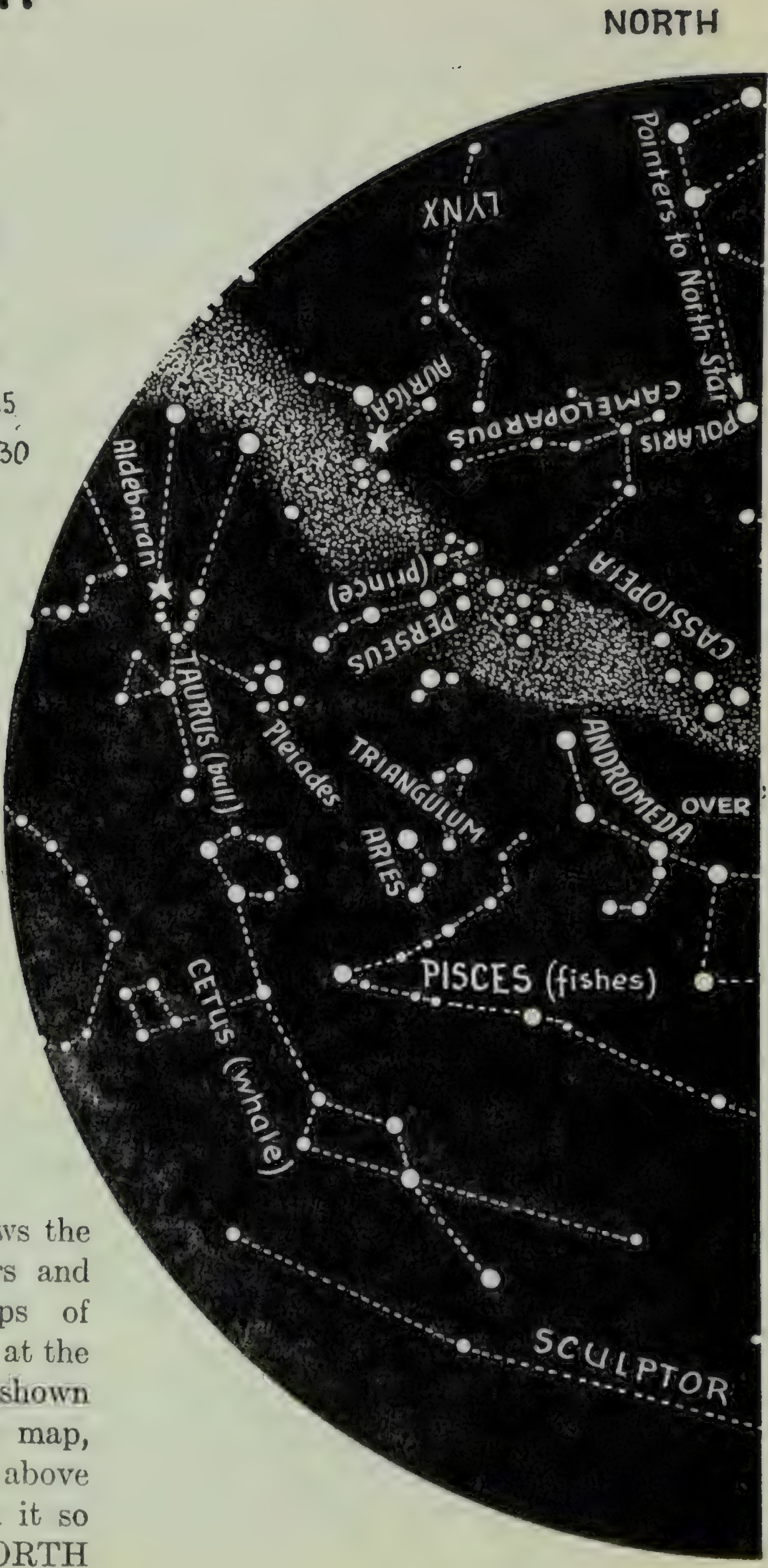
7. What planet do we know most about? Why?

8. Select one planet and tell all you know about it.

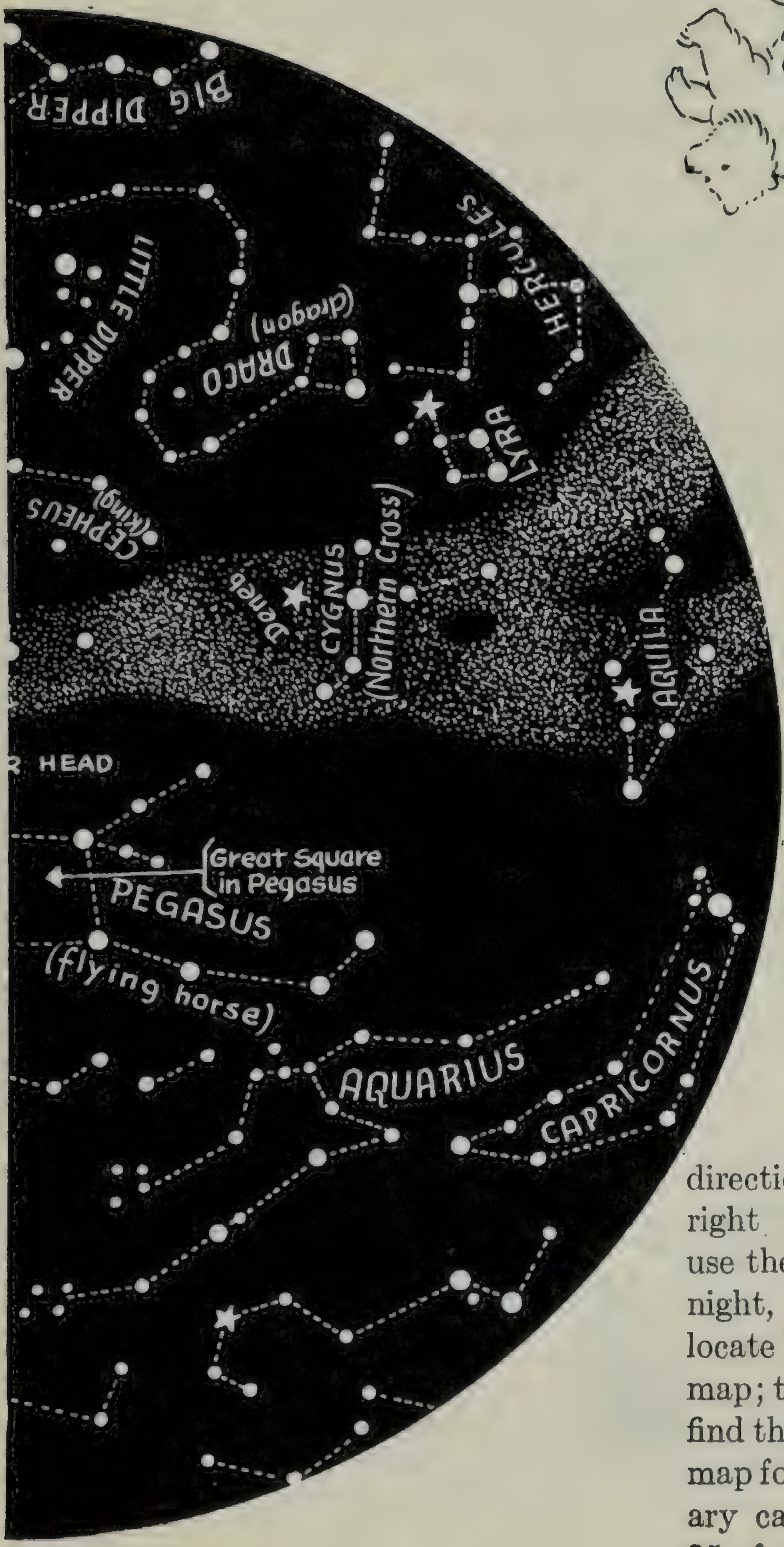
STAR MAP

FOR
NOVEMBER
AND
DECEMBER

9 p.m. Nov. 1-15
8 p.m. Nov. 15-30
7 p.m. Nov. 30-Dec. 15
6 p.m. Dec. 15-Dec. 30



This star map shows the positions of the stars and constellations (groups of stars) as they appear at the times and dates shown above. To use the map, hold it upside-down above your head, and turn it so the side marked NORTH faces north. The other



directions should be in their right places. When you use the star map outside at night, use a flashlight to locate constellations on the map; then turn it off as you find them in the sky. A star map for January and February can be found on page 85 of *Adventures in Science, Book V*.

9. Sometimes, newspapers publish descriptions of planets which can be seen at a certain time. Watch for these descriptions and try to locate the planets in the sky.

10. Draw a chart of the solar system. Be sure to include the **asteroids**.

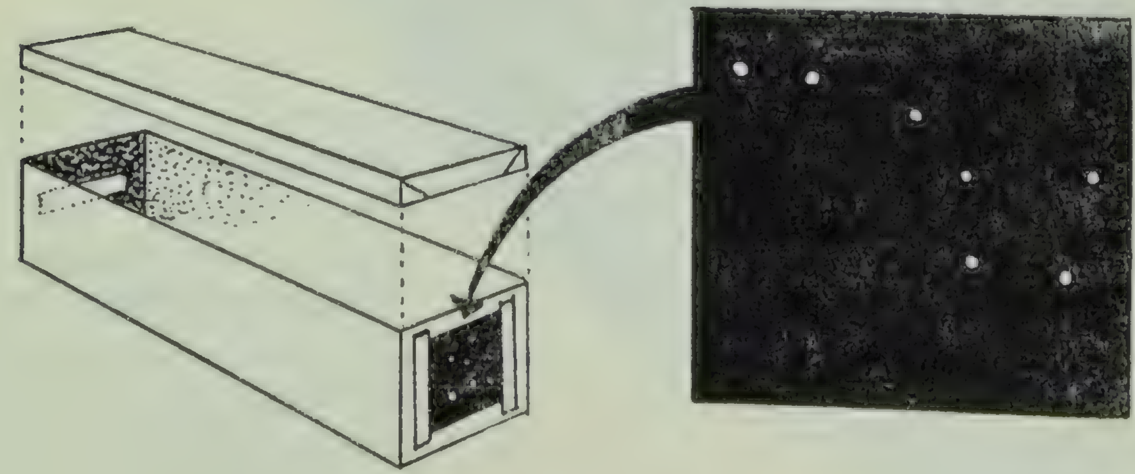
11. Keep a pictorial record of the phases of the moon for a month. (See Adventures in Science, Book 5, page 86).

12. What are shooting stars? Watch for them in the sky.

13. Using clay or other modelling material, make the sun and its planets. The ball representing the sun should be about as large as a tennis ball, and those representing the planets should be the size of small marbles and beads.

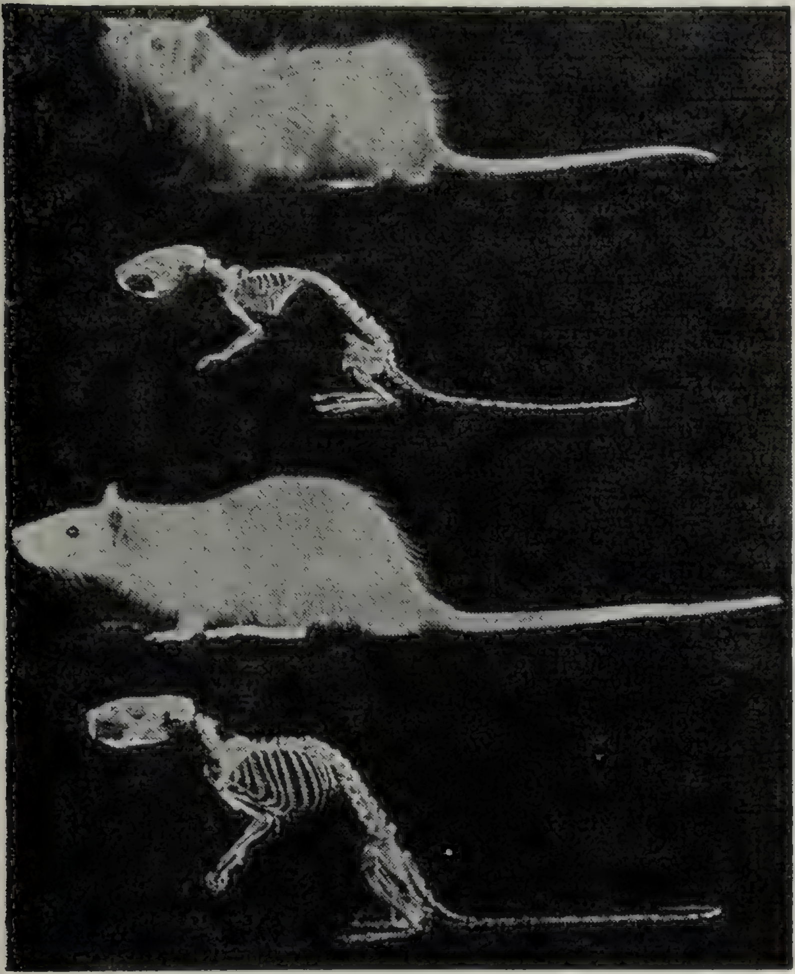
14. Learn to recognize the winter constellations (groups of stars) by using the star map on page 74 and 75. To use the map, hold it upside-down above your head, and turn it so that the north side of the map is toward the northern sky. At night, outdoors, use a flashlight in reading the map.

15. With a shoe box or other similar box and some heavy black paper, make a star peep box like the one shown below. Use a needle to punch *small* holes in the black cards in the shapes of constellations. With the lid and one card in place look through the peep box toward a light.



WHAT FOODS DO OUR BODIES NEED?

One day Bob and Roland were having lunch. "I read that you can stuff yourself full at every meal and yet not be getting enough to eat," said Roland. "Sounds serious," replied Bob. "I wonder what it means?"



The kind of food we eat is very important. These were twin rats, exactly alike at first. The top one was fed only meat, potato, bread, and butter. He has poor fur and is light in weight. His bones show his food lacked calcium and vitamins. The lower rat had plenty of milk and vegetables as well as meat, potato, bread and butter. He is big and healthy. His bones are strong and well formed. He ate the right kinds of food. (U.S. Bureau of Human Nutrition.)

The pupils of Western School did not like to leave a topic they did not understand. So, when Roland suggested that they try to find out more about food, Bob quickly agreed. "We can make it our problem for some science lessons," he said.

Likely you have read how sailors and explorers of early times often became sick on long voyages or when spending a winter in a new land. This would happen when they were unable to secure fresh food.

Their mouths and gums became sore and their limbs swollen and painful. They were ill with a disease called *scurvy*. When fresh food was again available, the men became well. Later, doctors learned that if lime, orange, or lemon juice was added to the diet, people did not fall ill with this disease.

The bad effects of not eating the right foods do not always end in illness. Nevertheless, they can seriously interfere with your growth, health, and even your happiness. A builder, when constructing a house, must use wood, concrete, iron, plaster, glass, and other materials, in order to build a good house. It is also necessary to use some of the same materials to repair the house when parts become worn out or damaged. Fuel must be burned to keep it warm. Similarly, if you wish to develop a good body and keep it in good repair, you must eat several food materials of the right kind. You also require fuel foods for heat and energy.

Finding Out About the Food We Eat

Everyone in good health likes to eat. We like to eat because our bodies require food. Hunger is simply the way our bodies have of telling us that they need more food.

Different kinds of food serve your body in different ways. Some foods provide the energy or strength which enables your body to move. Some help to keep your body warm. Other foods keep your body in good repair and working properly. You may over-eat as far as quantity is concerned, and yet not be getting sufficient of certain kinds of food necessary to keep your body working well.

Let Us Experiment to learn more about the foods our bodies need.

Experiment No 1: Perform experiment No. 2, page 32. This time try more foods such as apple, orange, bread, crackers, cake, oatmeal, nuts. Keep a record of those that show blue.

Starch is known as a **Carbohydrate** because it is composed of three substances called carbon, hydrogen, and oxygen, with the hydrogen and oxygen in the same proportion as in water. Another carbohydrate that is well known to us is sugar.

Carbohydrates (starch and sugar) are energy producing foods. *Energy is power to do work.* When you work or play, that is, when you move your arms, legs, fingers, or head, you use up carbohydrates which you have eaten. Even when you are asleep, your body is working (breathing, digesting food, carrying on repairs). Carbohydrates are like fuels, and combine with oxygen in your body to produce heat to keep your body warm.

Some Carbohydrate Foods Are:

Bread
Cereal
Crackers
Oatmeal
Potatoes
Rice
Beans
Ripe fruit
Sugar
Cake
Cornstarch
Grains

Experiment No. 2: Place crushed peanuts, other nuts, or sunflower or flax seeds (with shells removed) on a piece of paper. Heat *gently.* Or, merely press the crushed materials on to the paper. A greasy mark indicates the presence of *fat.*

Fat, like carbohydrates, is composed of carbon, hydrogen, and oxygen, but there is less oxygen. Also like the carbohydrates, fat is an energy-producing food

You should eat some of these foods every day. (1) *Milk*—1 to 1½ pints a day. (2) *Fruit*—citrus fruit or tomato or their juices, other fruit. (3) *Vegetables*—potatoes—other vegetables, preferably leafy, green or yellow, often raw. (4) *Cereals and Bread*—whole grain cereal, bread with butter. (5) *Meat and Fish*—meat, fish, poultry, eggs, dried beans, cheese. (Associated Milk Foundations photo.)

Some Foods Containing Fat Are:

- Butter
- Margarine
- Fat meat
- Egg yolk
- Nuts
- Cheese
- Cream
- Salad oil
- Bacon

Experiment No. 3: Moisten some flour to make a stiff ball of dough about the size of an egg. Allow it to stand for one-half hour. Next tie a cloth around the dough to form a small bag. Place the bag in a vessel of water and work the dough vigorously with the fingers. Change the water at intervals until it remains clear.

(a) Into some of the wash water pour a few drops of iodine. What is your conclusion?

(b) Open the bag and notice the soft gummy substance that remains. Try stretching it—notice how elastic it is. It is called *gluten.* Gluten is the secret of good bread-making flour.

In making bread, yeast is mixed with the dough. The dough is then placed in a warm location to rise. Carbon dioxide gas, formed by the yeast, produces bubbles or cavities throughout the dough. Because of the elastic gluten in the dough, the walls of these cavities stretch as more carbon dioxide is produced. In the heat of the oven, the carbon dioxide and the moisture are driven off and the walls of the cavities become firm. *Examine a slice of bread.*

Gluten is a **Protein.** However, not all protein is gluten. Protein is an important part of our food. When you work or play, you wear out parts of your body. Protein repairs the worn parts. In fact, protein builds the muscles in the first place. It supplies your body with materials needed for growth. The body can also use protein to produce energy, but its chief use in our body is muscle building and repairing.

Protein, like the carbohydrates, contains carbon, hydrogen, and oxygen, together with another substance called nitrogen.

Some Protein Foods Are:

Eggs
Fish
Milk
Lean meat
Peas
Beans
Cheese
Nuts
Soybeans

Experiment No. 4: If you have a way of burning food (for example, a bit of bread or potato in a crucible over a burner) you would find that at last only ashes remain. This is the mineral material that was in the food. It is called *ash or mineral matter* and is an important part of our food.

Minerals, such as calcium and phosphorus, are necessary for strong bones and teeth. Iron and copper help to build new red blood cells. About 14 different minerals are required to keep your body healthy.

Some Mineral Foods Are:

Bread
Vegetables
Eggs
Meat
Milk
Buttermilk
Green, leafy vegetables
(cabbage, lettuce,
spinach, celery)

The pupils of Western School began to feel that meals would now be more enjoyable. They knew what to eat to keep themselves healthy and strong. "There is one more kind of food we need," said Miss Hughes. "It is very important. Perhaps you can find out about it."

The next day, Anne and several others were able to work out a very good story about vitamins.

Anne reported that scientists performing experiments in feeding animals learned that certain foods did not keep the animals healthy while other foods did. As far as they could see, both foods should have been equally good. Then the scientists discovered that certain foods contain very important substances which they called **vitamins.**

This girl is wisely (and cheerfully) pushing aside a lunch consisting of a chocolate bar and soft drink. Instead she plans to eat a healthful, well-balanced meal. What are some of the foods on her tray and in her hand? Why is she making a good choice for her lunch? (Nat. Film Board photo.)

Nancy added that vitamins are chemical substances. Experiments have proved that they are necessary for good health. Each is named with a letter of the alphabet as A, B, C, and so on. Each kind of vitamin has a different effect upon the body.

Gordon had information about some of the vitamins:

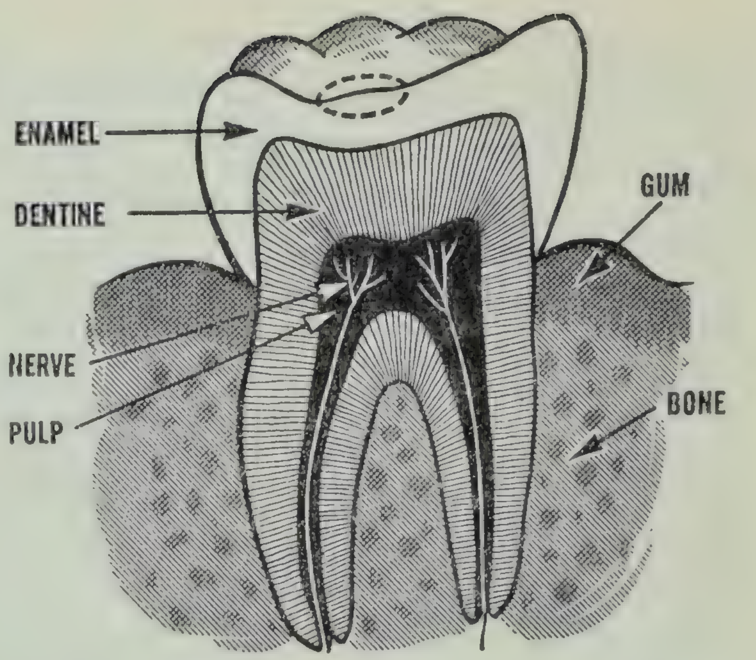
A—helps growth, vision, and general health.

B—aids growth, general health, and the work of the nerves and skin.

C—helps growth, appetite, and teeth.

D—aids in building strong bones. Sometimes referred to as the sunshine vitamin.

Other vitamins, such as E and K, have special values in the work of the body.



A tooth cannot repair itself. Decay begins in the enamel (see dotted line) and unless checked will spread through the dentine into the pulp. Sweet foods and drinks are thought to cause tooth decay. Proper food and care will help you to have good teeth.

SOME FOODS THAT SUPPLY VITAMINS ARE:

Milk
Eggs
Lean meat
Liver
Oranges, lemons, grapefruit
Cod liver oil
Green vegetables
Butter and margarine

All the pupils agreed that during the time you are growing it is most important to eat enough of the right kinds of food, if you wish to look and feel well and have plenty of energy for the things you want to do.

Problems and Things To Do

1. Working with a group of classmates, plan a good *breakfast*, a good *lunch*, and a good *dinner*. Be sure to plan for a good *balance* of all the kinds of food your bodies need.

2. Two boys were having lunch. One had a jam sandwich, candy, and a soft drink. The other boy's lunch included a ham

sandwich, vegetable salad, fruit, and milk. Which boy had the better lunch? Why?

3. Why do our bodies require more carbohydrates during the winter than they do in summer?

4. Collect colored pictures and use to make posters telling facts about foods. But do not stop with the posters. Practise (use) what your posters tell you to do.

5. Tell why the kinds of food you eat is just as important as the amount of food you eat.

6. Be sure to use what you know about foods when selecting the things you eat from day to day.

Why is it especially important to eat the right kinds of food while you are young and growing?

What Are YOU Learning To Do?

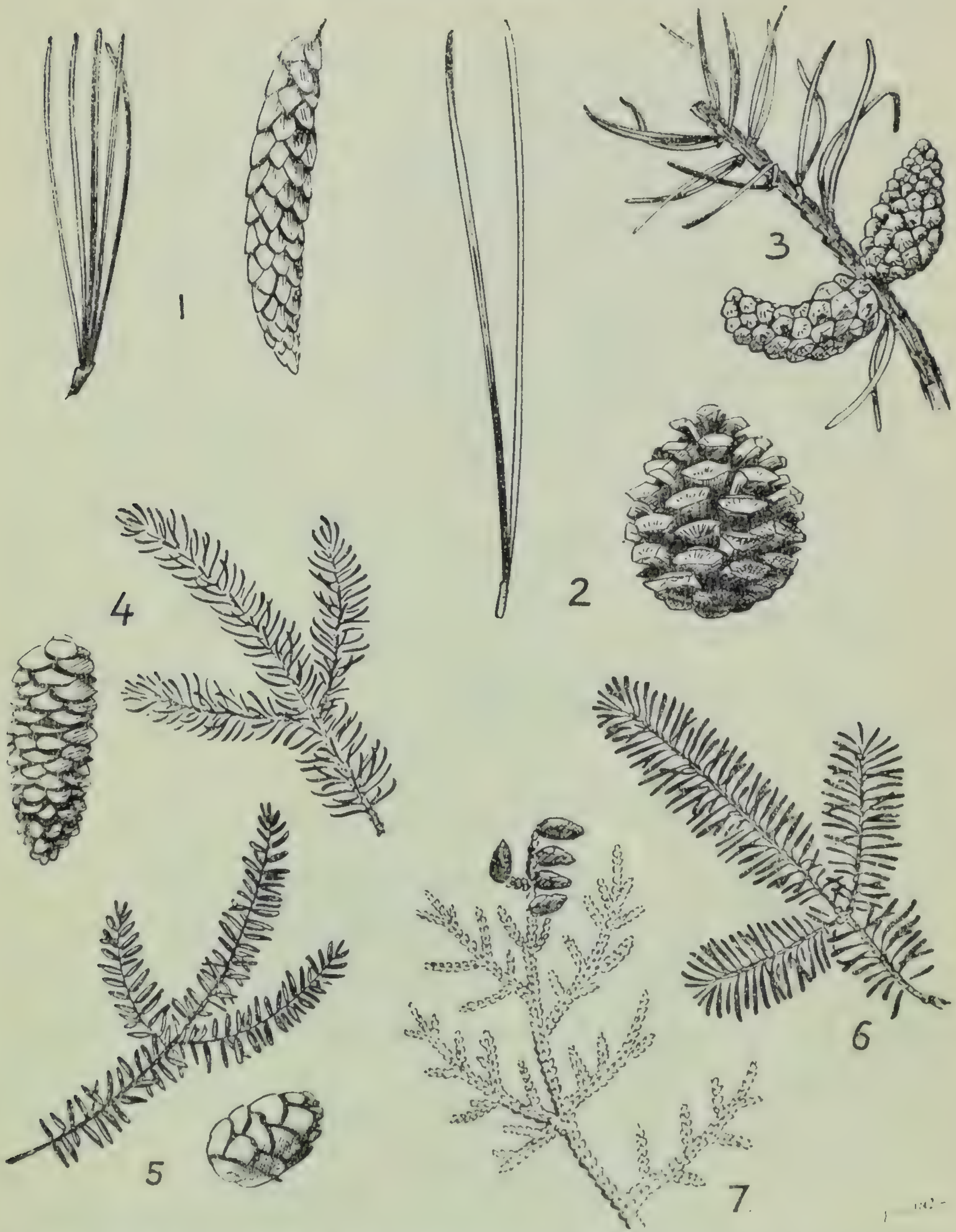
Sometimes, when studying science, we think only about information and ideas. It is just as important to learn how *to do* certain things.

SOME "DO" GOALS TO TRY FOR

- To recognize and work out science problems.
- To keep a science problem in mind, while reading, observing, and thinking about it, in order to find the true answer.
- To arrange information well and prepare clear, accurate reports.
- To plan and carry out science experiments.
- To find the most important ideas.
- To check facts in several ways (reading, observing, talking with others) to be sure they are right.
- To observe and enjoy living things out doors.

HOW MANY OF THESE THINGS CAN YOU DO?

EVERGREEN TREES



Winter is a good time for studying evergreen trees. Find as many as you can of the evergreens shown above. 1, *white pine* needle cluster and cone; 2, *red pine* needle cluster and cone; 3, *jack pine* needle clusters and cones; 4, *white spruce* needles and cone; 5, *hemlock* needles and cone; 6, *balsam fir* needles; 7, scales and cones of *white cedar*.

LIGHT, THE GIVER OF LIFE AND SIGHT

How different from a gray, cloudy day is a day that is bathed in warm life-giving sunlight! The sun is like a great lamp sending light and warmth to the earth. Light travels at the rate of 186,000 miles a second. Only eight minutes are required for light to travel from the sun to the earth, a distance of 93,000,000 miles.

Plants and Animals Need Light

Observe plants to learn how they respond to light. Scarlet flax, California poppies, and other plants open their blossoms when the sun is shining and close them at night. Plants growing in the dark are spindly and white, but become green and sturdy when placed in sunlight. How green plants reach up for light! They need light to make food and to live and grow.

Most animals, also need sunlight. Growing animals, especially, need sunlight to build strong bones and

Here are deer feeding upon plants. Tell a story to explain why neither the deer nor the plants could live without sunlight. (Harold Vickers photo.)

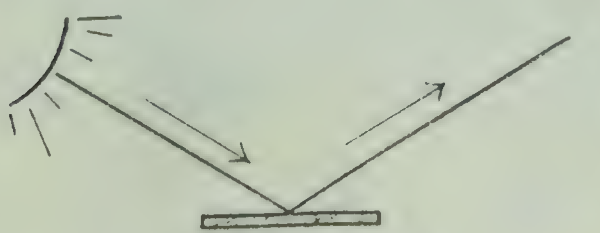
healthy bodies. Many animals are more active during the day than they are at night. However, some animals do not like strong sunlight. The earthworm, for example, remains underground during the day, venturing out from its burrow only during the hours of darkness. But all animals depend upon light in some way. Without light, grains, grasses, trees, and other green plants cannot grow. If there were no plants, there would be no food for animals. As you know, all animals depend, one way or another, upon plants for their food supply.

The sun affects, in some way, the lives of all plants and animals. If the earth should cease to receive light and heat from the sun, what a different earth there would soon be! In a short time the plants would all be dead. And, without the food supplied by the plants, the animals would soon disappear.

How Do We See?

We know that we cannot see in the dark, which is just the absence of light. It is evident that light has something to do with our ability to see. We can only see when there is sufficient light—when there is no light we cannot see.

Have you ever held a mirror in your hand so that the rays of the sun fell directly upon it, throwing a spot of light to the floor, wall, or ceiling? Possibly, when standing with your back to the sun, you have had the rays of the sun thrown into your eyes from a nearby shiny surface. Very



Light is reflected.

This is an example of the reflection of light by the surface of still water. Observe how the "water mirror" in the foreground reflects the images of the mountains and trees.

smooth, shiny surfaces will catch rays of light from the sun or other source and throw them back or *reflect* them. When you throw a ball against a wall it bounces back towards you. Similarly when light strikes many objects, it bounces back or is reflected as we call it. A mirror reflects light. The smooth surface of water reflects light. Highly polished metal objects, desk tops, and floors reflect light.

Let us suppose you are looking at a book. How can you see it? The answer is that rays of light from the sun, or an electric lamp or an oil lamp, fall upon the book and are reflected to your eyes. Dull objects, such as clothing, stones, soil, grass, sidewalks, reflect light just as smooth, shiny objects. However, dull objects reflect only a part of the light that falls upon them. But they reflect sufficient light to enable us to see them.

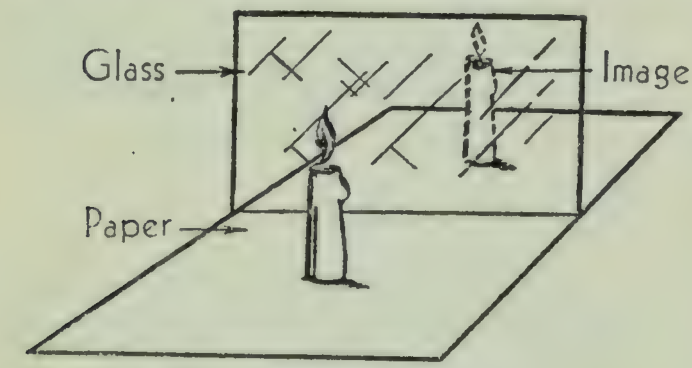
When you see a beautiful picture, a field of ripening grain, a boy batting a ball, or a bird flying through the air, light is, in every case, falling on the object and being reflected to your eyes. An image or "picture" of the object is formed in the eye.

Luminous objects, which themselves give off light, such as the sun, stars, the white hot filament of an electric light, and the flame of a kerosene lamp, are visible by their own light.

An Experiment with a Mirror

An interesting experiment to find that the image or picture of an object is as far behind a flat mirror as the object is in front may be performed as follows:

Place a sheet of foolscap on your desk. Across the centre support a small pane of clear window glass in a vertical position, Place a short lighted candle about 6 inches in front of the sheet of glass (your mirror). Stand behind the candle and look into the glass. You will see an image of the candle. Place a second lighted candle behind the sheet of glass and move it back and forth until it is standing exactly in the image of the other candle. Draw a line on the paper to mark the position of the glass, and mark the position of each candle. Remove glass and candles. Measure the distance from each candle to the glass. What is found to be true about the two distances? Using the facts learned in this experiment, fill in the blanks in the following sentence: The image of an object is as far ——— a flat mirror as the objects is in ——— of the mirror. A plane mirror is a flat mirror.



The image in a mirror.

Examine the images formed in flat mirrors. Observe that objects close to the mirror are in the foreground of the image in the mirror and that objects back from the mirror are in the background of the image.

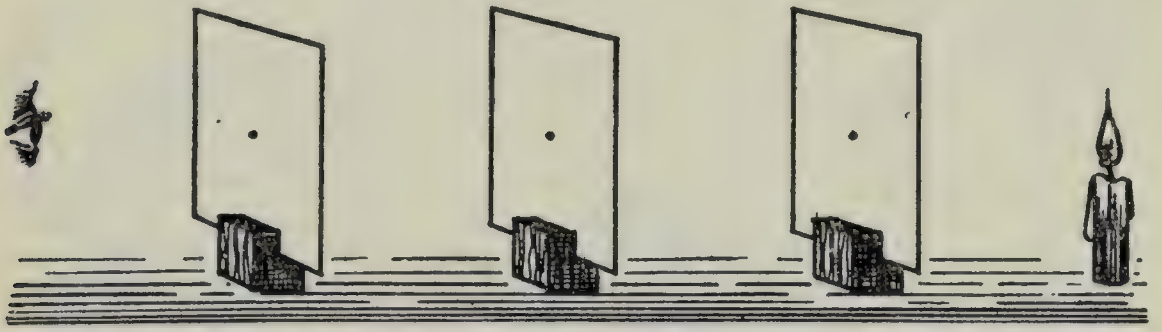
Does Light Travel In Straight Lines?

One day Bill, who was standing a short distance from Norman, called to him to look at a bird near by. But Norman could not see the bird because it was just around the corner of the school. Why could he not see it?

Remember we see objects by light that is reflected from them to our eyes. Why was light from the bird travelling to Bill's eyes but not to Norman's? Why can we not see around corners?

Learn for yourself whether light travels in straight lines by performing the following experiments:

Secure two pieces of cardboard about 4 x 4 inches. Punch a hole ⅛ inch in diameter in the centre of each cardboard. Mount the cards on two small blocks of wood to hold them upright. (See diagram.) Light a candle and place it on a table. Arrange one cardboard about one foot from the candle so that the flame may be seen through the hole in the centre of the card. Place the second cardboard out one foot from the first in such a position that the flame of the candle may be seen when looking through both holes. Now, move one of the cardboards a little to one side. Can the flame of the candle still be seen through the holes in the cards? Why not? Does light travel in crooked lines? How does it travel?



Light travels in straight lines.

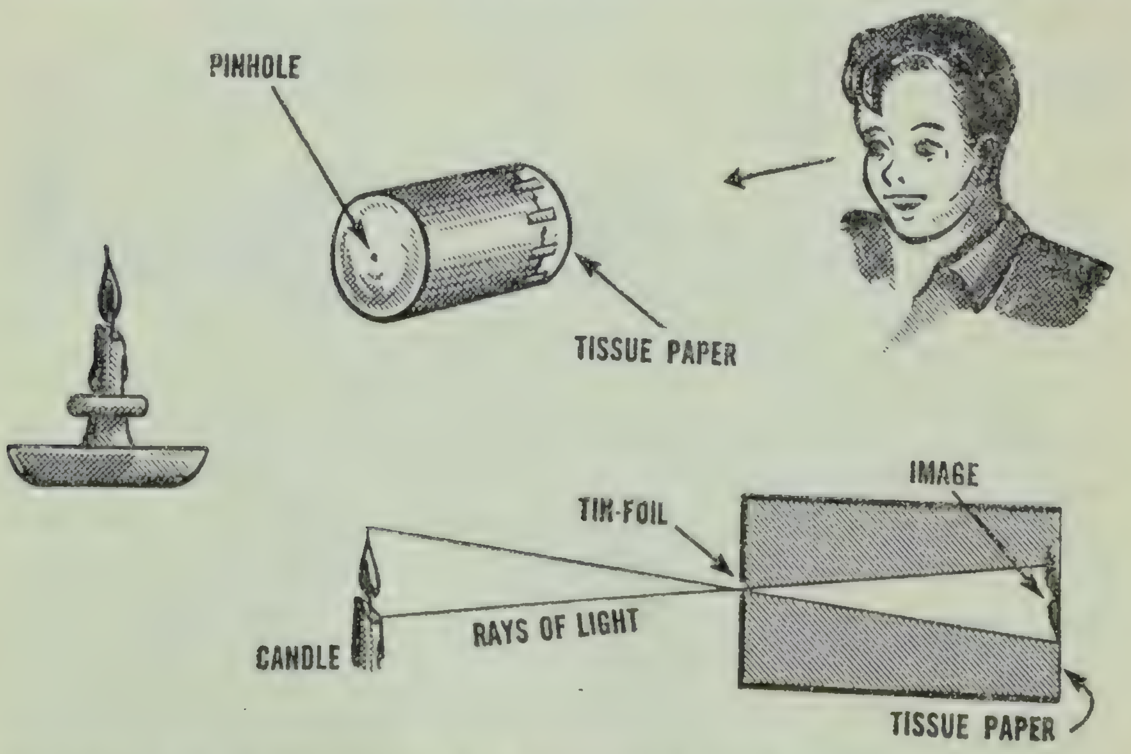
After you have performed this experiment, consider such problems as the following: Why is an object on one side of a body through which light will not pass, not illuminated by a light on the other side of the body? Why are shadows cast by objects that do not let light through them?

A Pin-Hole Camera

An interesting activity would be the making of a pin-hole camera.

To make a pin-hole camera, first secure a cardboard box, such as a cereal or a shoe box. Remove one end from the box and over this end paste a sheet of thin tissue paper. Be sure that the tissue paper is smooth. In the other end of the box cut an opening in the centre about one inch square. Over this opening paste a piece of tin-foil or black paper. Carbon paper will do but tin-foil is better. Using a pin, punch a *small* hole in the centre of the tin-foil. If tin-foil or black paper cannot be secured, a small hole in the centre of the end of the box will give fairly good results. The box is now ready to use. It is really a crude camera. A dark room is required, (at home or at school).

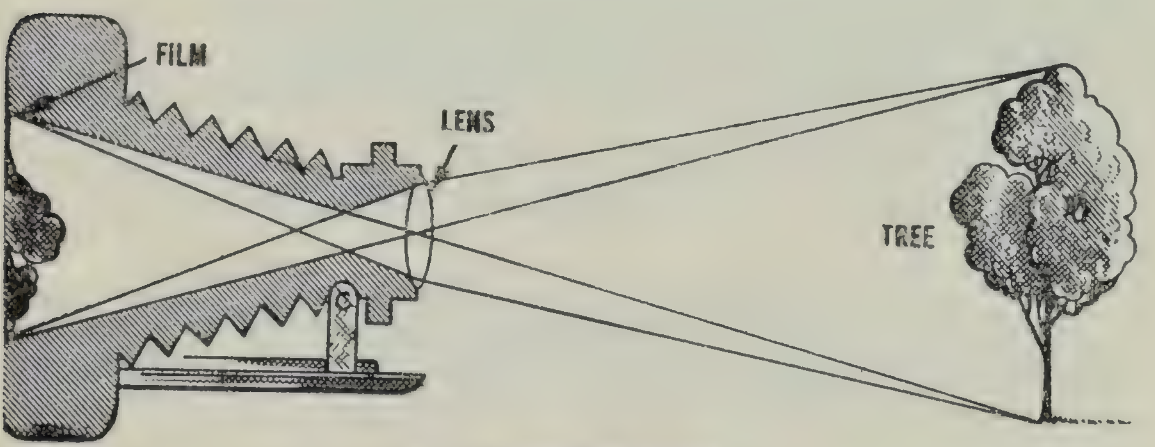
Place a lighted candle on a table in a dark room. Hold the camera so that the candle is 6 to 8 inches from the pin-hole in the



Showing the construction and operation of a pinhole "camera."

one end of the camera. Try to arrange the camera in such a position that light from the candle will shine on the tissue paper in the back of the box. When this is done, a small image of the candle will be formed on the tissue paper. If good results are not obtained, try making the pin-hole a little larger, but be careful not to enlarge it too much. The image will be found to be upside down. The diagram will show why this is so. Move the box farther away from the candle, then nearer to it. What effect has this upon the image? The image is produced because rays of light from all parts of the candle pass through the pin-hole and strike the tissue paper at the back, forming an image of the candle. The image is inverted because the hole is small and the rays of light cross each other as they pass through it.

Make a diagram of a side view of the camera, and draw lines from the camera to corresponding parts of the image to show how the image is formed.



A focused camera

Problems and Things To Do

1. Place a growing plant in a sunny window for a few days. Notice how the leaves turn towards the light. After a few days, turn the plant around so that the leaves are turned away from the window. What change now takes place in the position of the leaves?

2. How fast does light travel?

3. Outline an experiment to show that light travels in straight lines. Draw a diagram to illustrate your experiment.

4. Describe a pin-hole camera. Draw a diagram to illustrate how the image is formed in a pin-hole camera. Why is the image upside down?

5. How do plants depend upon sunlight?

6. In what ways do animals need light from the sun?

7. Why should we spend as much time as we can outdoors in the sunlight?

8. How does a shadow help to show that light travels in straight lines?

9. Give an example to show that we depend upon reflected light to enable us to see.

10. On a bright, sunny day, look around the schoolroom for examples of the reflection of light.

11. Draw a diagram to show how light is reflected.

12. All objects reflect light to some extent. What kind of objects reflect light best?

13. Explain how we see an object (1) during the day and (2) at night.

14. Make a diagram to illustrate the position in the mirror of images of several objects placed at different distances in front of the mirror.

15. Hold a piece of writing or printing in front of a mirror. Account for what is observed.

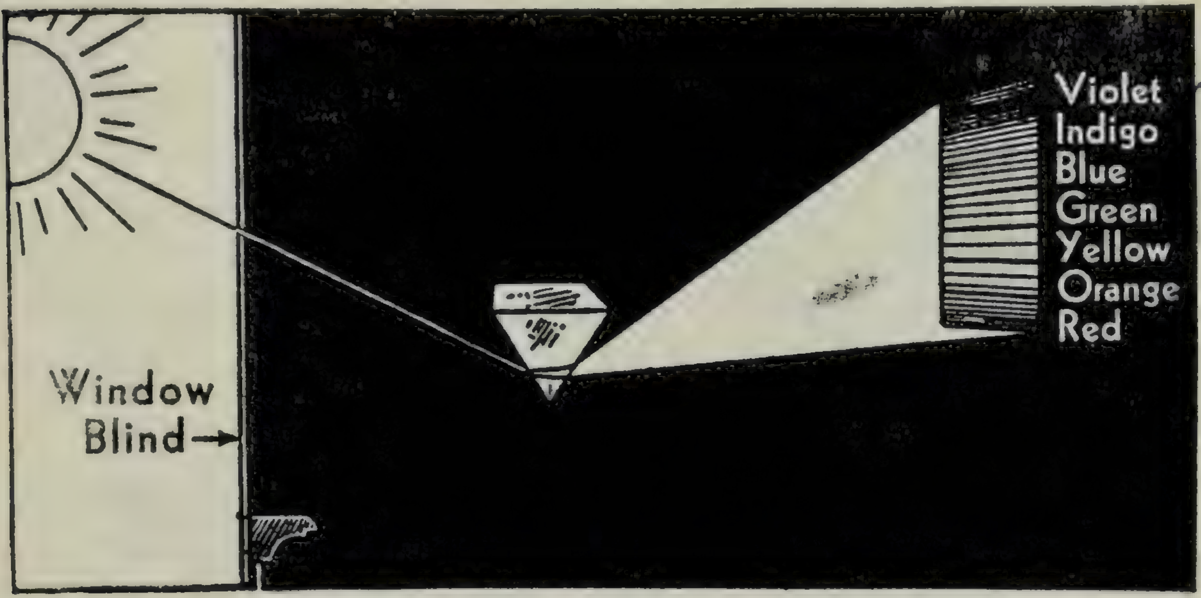
16. Study images in flat mirrors in a *horizontal* position, such as surface of water in a pan, still water in a lake, glass or polished metal mirrors. When you see in still water the image or reflection of the opposite shore, the image is upside down. Why?

17. What uses are made of mirrors in our homes, in automobiles, and in stores?

NOTE—A piece of glass blackened on the back by means of a lighted candle makes a useful experimental mirror.

What Gives Objects Their Color?

A colored dress may appear to be a different color when seen under electric or lamp light than it does in daylight. If you have never noticed this, experiment to see for yourself. What has light to do with the color of dresses and other objects? The following experiment will help you to solve this problem:



An experiment **to show how white light can be broken up into seven colors.**

Darken a room, but allow a fine ray of light to enter through a small hole in the window blind. Hold a glass prism or place an aquarium so that the light shines through it and falls on a white surface nearby. You should then see, on the white surface, seven colors: *red, orange, yellow, green, blue, indigo,* and *violet.*

In the experiment just described, what happened to the ray of white light from the sun as it passed through the prism? It was bent and broken up into seven different colors. This shows us that white light is not a single color but is composed of seven colors. A glass prism separates the colors so that we can see not the white light but the seven colors of which it is composed.

We are now ready to learn why objects have different colors. We have already learned that when light falls on an object, it is reflected. But only part of the light that strikes an object is reflected. Part of it is absorbed or taken in by the object. Therefore, when white light, which is seven colors, falls on an object part of it is absorbed. If all of the colors but red are absorbed, then only red is reflected to our eyes. The result is that the object appears to us to be red in color. The color of an object, therefore, depends upon the color of light that it reflects to our eyes.

Green grass is green because grass absorbs all the colors but the green. Green only is reflected.

A *blue* book cover is blue because it absorbs all the colors but blue. Blue only is reflected to our eyes.

A *black* object reflects very little if any light. Black, therefore, is really no color. We see black objects because other objects surrounding them reflect light.

A *white* sheet of paper reflects most of the colors of the light.

Care of the Eyes

Each of us has one pair of eyes, and one pair only. If our eyes are damaged, they can never be replaced.

Six muscles move your eye up and down and from side to side. Other muscles make the pupil, or tiny opening, larger or smaller, and cause the lens to become

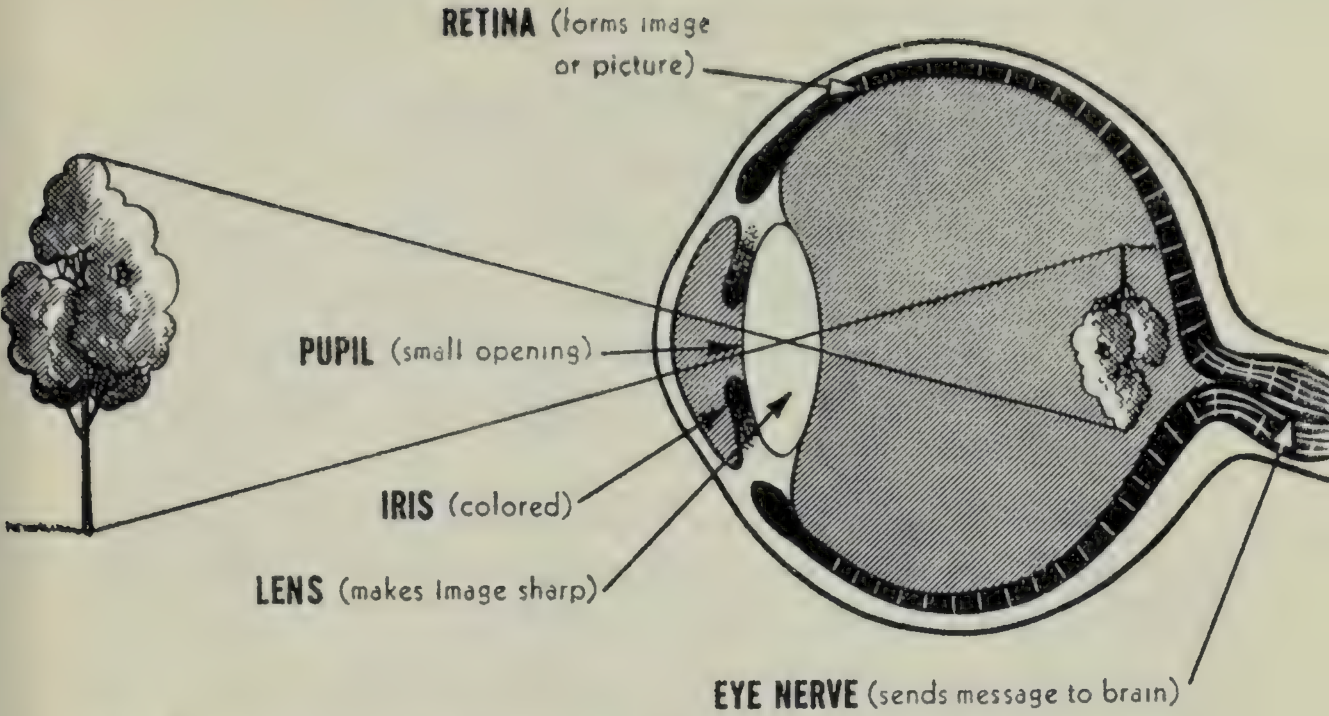

RETINA (forms image or picture)
PUPIL (small opening)
IRIS (colored)
LENS (makes image sharp)
EYE NERVE (sends message to brain)

Diagram showing (1) the parts of an eye, and (2) how the things you see are pictured on the retina at the back of the eye.

thicker or thinner in order to make the picture on the retina sharp and clear. If the light is too dim or too bright and glary, the eye muscles must work too hard to enable you to see clearly.

It is easy to understand that we should be careful not to over-work our eyes by doing fine work or reading in poor light. When you are engaged in work that requires close attention from your eyes, be sure to work near a window or a good lamp.

Too much light is also harmful to your eyes. Strong light from a bright lamp or the sun shining directly into your eyes will strain them. Always do fine work or read so that a good light falls on your work or book but be sure that it is not shining directly into your eyes. A glare of light reflected from a shiny surface to your eyes is to be avoided. Your eyes are worth the best care you can give them.

Problems and Things To Do

1. Outline an experiment to show that white light is made up of several colors. Make a diagram.

2. Name the seven colors of which white light is composed.

3. Watch for a rainbow. What colors can you find in a rainbow? In the case of the rainbow, the drops of rain take the place of the glass prism in our experiment. They break the light of the sun up into several colors.

4. Stand between the sun and water spraying from a sprinkler hose. Look for a rainbow in the spray of water. In this case, what breaks up the light into the rainbow colors?

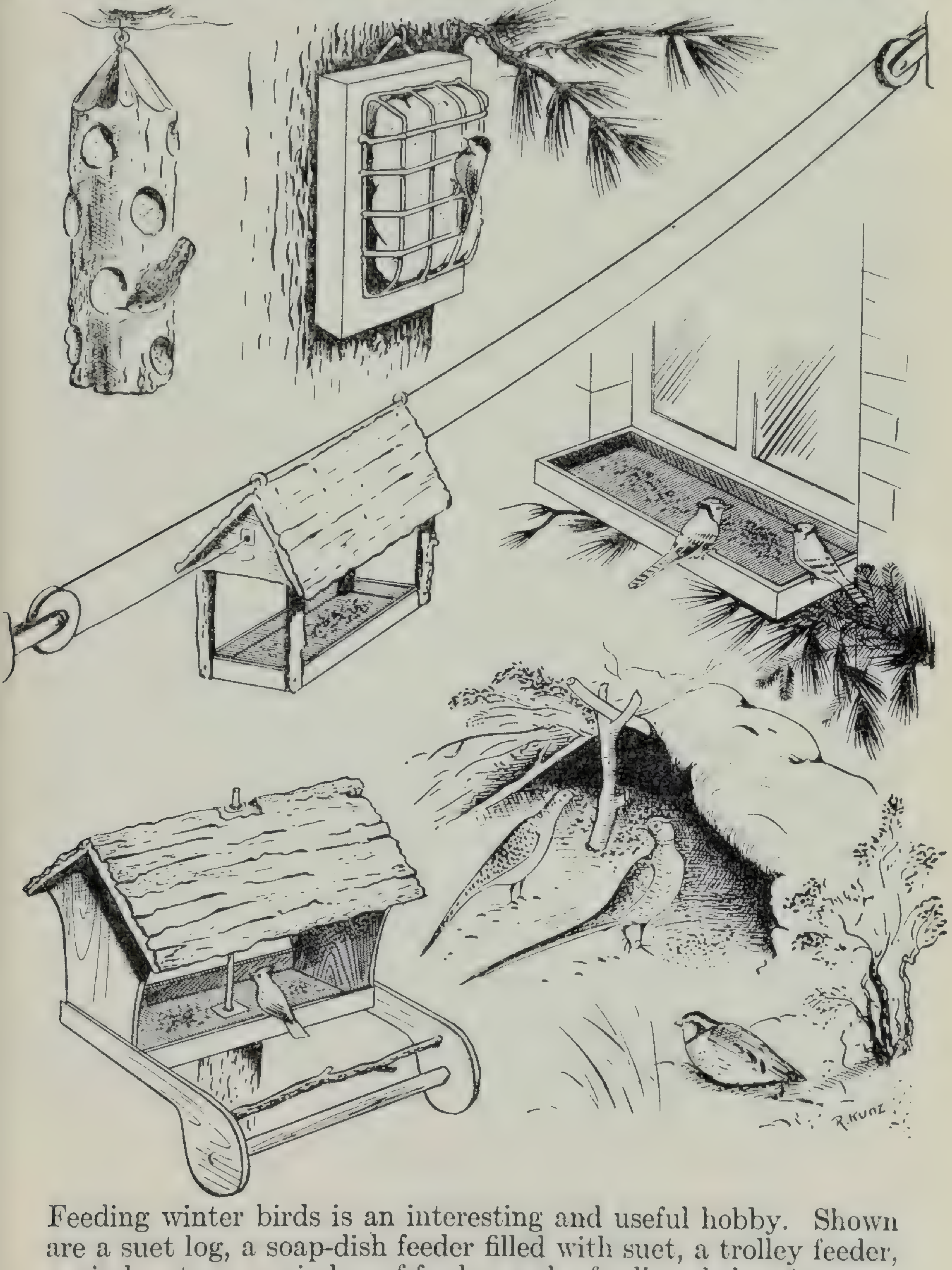
5. Upon what does the color of an object depend? Why is one book cover blue and another one red?

6. What color is black? How can you see a black object?

7. Using a diagram, explain how our eyes form pictures or images of the things we see, and send messages about them to the brain.

8. Make a list of rules for the protection of your eyes. Why should you protect your eyes?

WINTER BIRD FEEDING STATIONS



Feeding winter birds is an interesting and useful hobby. Shown are a suet log, a soap-dish feeder filled with suet, a trolley feeder, a window tray, a windproof feeder, and a feeding shelter for game birds.

HOW DO WE CONTROL AND MOVE OUR BODIES?

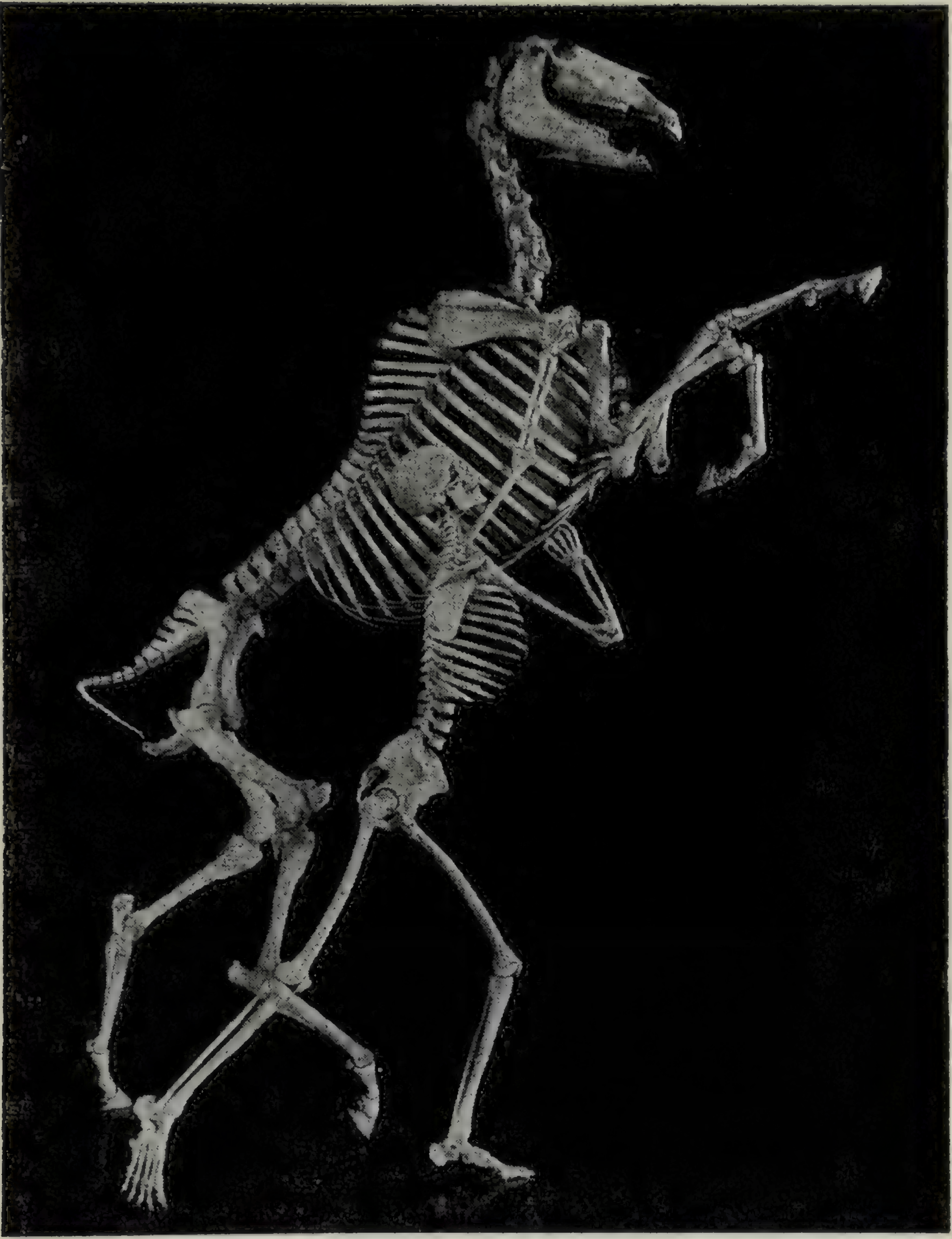
Science activities had been going very well in Western School. One day Jane said, "I think that we should know something about our bodies. They are rather important to us." After a discussion, it was agreed that some time should be spent in a study of bones and muscles.

"Each of us has a wonderful body," said Miss Hughes. "It is something like an engine. It burns fuel (food) and changes it into bone and muscle as well as energy or power to do work. We can tell our bodies to move and they do so. We can do very fine work such as picking up a small pin. We can see, hear, smell, and feel what is taking place around us. Most parts of our bodies can repair themselves when they become worn or injured. You have made a wise decision to begin a study of these wonderful bodies."

The Skeleton or Framework

There are more than 200 bones in your body! You can feel many of these in your hands, feet, arms, legs, back, ribs, and head. Together they form your *skeleton*, which serves as a framework and gives your body shape. Your bones also support and protect softer parts such as your muscles, heart, lungs, stomach, and intestines.

The bones in the various parts of your body (arms, feet, back) are joined together so they can move. Strong cords, called *ligaments*, hold these movable bones together at the *joints*. There are different kinds



Your skeleton is a very important part of your body. What three uses does it serve?

Many other animals also have a skeleton very similar to the skeleton of a man. Compare the skeletons of the horse and the man shown in this illustration. (American Museum of Natural History photo.)

of joints to provide for different kinds of movements. Your shoulder and hip joints, for example, are *ball-and-socket* joints which permit movement in several directions. An idea of a ball-and-socket joint can be formed by doubling up the fist of one hand and fitting it into the palm of the other hand. Knee and finger joints are examples of *hinge-joints* which permit movement in one direction only.

Our bones are living and in the case of young people are growing. They must have food and oxygen just the same as other parts of the body. If they are to remain healthy and strong, bones require a mineral called *calcium.* Milk is a good source of calcium for the body.

"It seems to me that the backbone is one of the most important parts of our skeleton," exclaimed John. "It holds our bodies erect." "You're right," replied Bob, "I was reading about the backbone last night. It is sometimes called the *spine* or *spinal column.* It consists of a long row of 33 bones or *vertebrae* joined together so they can move."

"That's right," added Gladys. "And each bone or *vertebra* has a hole through it. The holes form a long opening that extends the entire length of the backbone. Through this opening passes the *spinal cord* which is a bundle of nerves carrying messages to and from the brain and other parts of the body."

"Finally," said Miss Hughes, "we should know that between each two vertebrae is a soft cushion or pad of cartilege which keeps the bones from grinding against each other when they move. The head, arms, legs, and ribs are attached to the backbone or to bones attached to it. There are 12 ribs on each side of your body."

What Makes Our Bones Move?

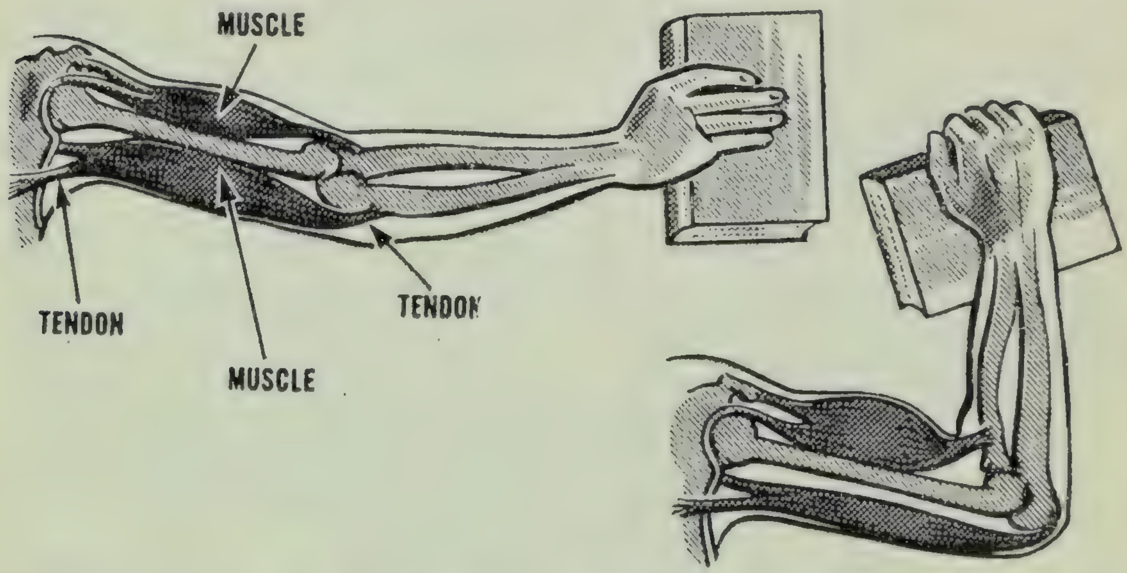
(The muscular system)

Your muscles move your bones. They are fastened to the bones by strong tendons. When the muscles move, the bones move.

Muscles work by thickening and shortening to pull on a bone and cause it to move. They often work in pairs. As one muscle pulls on a bone as just mentioned, the other relaxes and becomes longer and thinner to permit the bone to move. Muscles cannot push. They can only pull.

Heavier muscles provide protection for more delicate parts. For example, the internal organs in the lower part of your body are protected by strong abdominal muscles. The walls of the intestines, heart, and stomach are chiefly muscle.

Some of your muscles you can control. You can tell them to pull or relax. If you wish to throw a ball or run, the right muscles receive a message from the brain, and they move the right bones. Your muscles need to be trained by practice to do things well. They require exercise (walking, swimming, playing games) to keep them in good condition. They must also have plenty of rest.



Some muscles (the upper arm as illustrated) work in pairs. To move your arm one way (upward), the top muscle shortens and thickens. The lower muscle becomes thinner and longer. Your arm is *pulled* up. What happens to pull your arm downward?

Certain of your muscles work away continually by themselves. They are not under your control. The muscles of your heart, stomach, and certain other parts of your body keep working as long as you are alive.

The energy needed by your muscles to enable them to do their work is provided by combining oxygen and food. Your blood supplies the muscles with oxygen from your lungs and food from your digestive system.

How Are the Muscles Controlled?

(*The Nervous System*)

Suppose you wish certain muscles to move—perhaps in your arm and hand to turn a page in this book. A message is sent from your brain through a wonderful system of *nerves* to your arm and hand muscles. Certain muscles pull while others relax, and your arm, hand and fingers do what you wish them to do. Similar messages are sent when you wish to move your legs, head, or mouth.

Your nervous system is something like a telephone or telegraph system. Thousands of fine, white, thread-like nerves lead out from your brain. These form the *spinal cord* that passes through the openings in the vertebrae of the spine. The vertebrae protect the spinal cord. Nerves then leave the spinal cord between the vertebrae. They divide into smaller and smaller nerve fibres and go to every part of the body except the head. Other nerves lead out from the brain to the head. Your nervous system is controlled by your brain, which is completely covered and protected by the hard bones of your skull.

When you see, hear, smell, feel, or taste something that results in your wishing to do something, for example, you see a flower and wish to bend over to examine it, a message is sent to your brain. Then, you "think" what you wish to do, and messages go out to the right muscles. One set of nerves carries messages *to* the brain. Another set carries messages *from* the brain.

Not all messages travel to the brain to be completed. Suppose you accidentally touch something very hot. You know how your hand is quickly jerked away before you even think about it. In this case, the message from the "hot spot" goes only to the spinal cord and then back to your fingers for quick action. This is a means of protecting your body from many kinds of injury. A message finally goes to your brain so that you know what has happened, but not before your hand is pulled away from danger.

Your nervous system tells you what is going on around you. It is most important to take good care of this valuable part of your body. Plenty of sleep and rest are very necessary.

Problems and Things To Do

1. Check the facts stated and illustrated in this book by reading in other books.

2. Suppose that you wish to kick a football. Explain how your leg muscles would work.

3. What messages would have to be sent and received through your nervous system in order to result in the action described in Question No. 2?

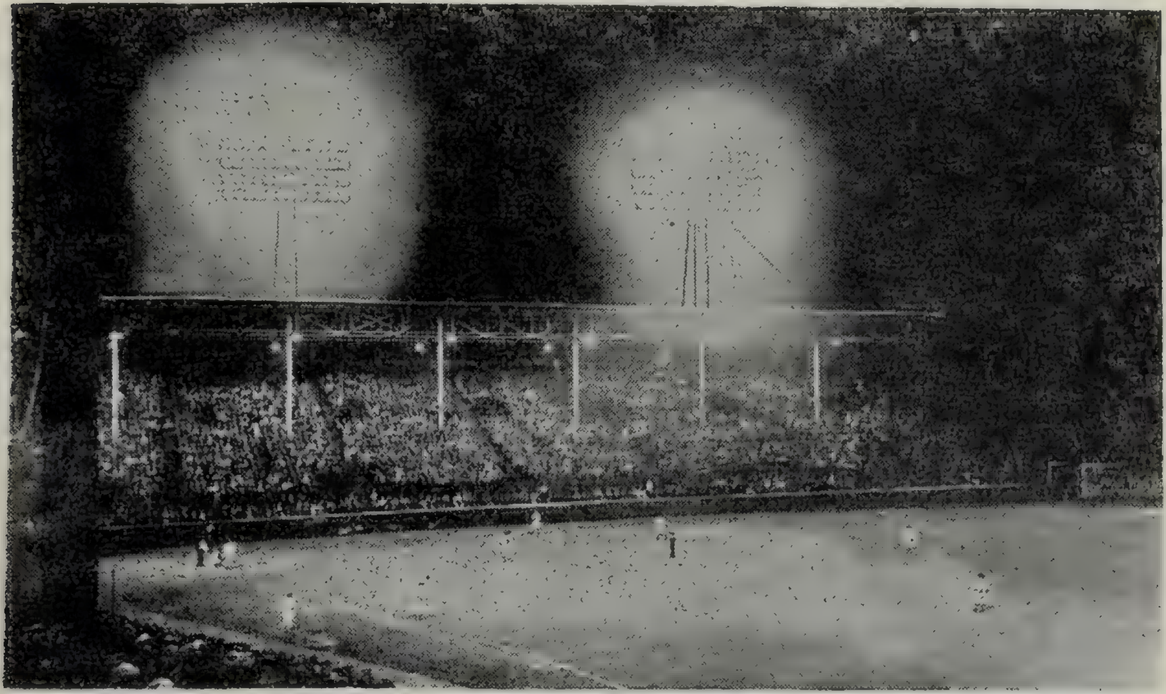
4. What is the difference between the spinal column and the spinal cord? What is the work of each?

5. What is energy? How are the muscles provided with the energy they need to do their work?

6. Sometimes our bones, muscles, and nerves seem to work without much thought on our part. Nevertheless, they are living and growing. They can be injured or damaged. Write a paragraph describing the need of taking good care of these parts of our bodies. What care should be given to them?

ELECTRICITY FOR LIGHT AND POWER

How widely electricity is used! We cannot see this magic power, but we can see all around us ways in which it can be put to work. In places where electricity is available, it is used to light our houses, schools, and places of work; to operate street lights and neon signs; to put into motion a great many kinds of machines in factories; to operate many labor-saving appliances and other conveniences and equipment in our homes. Some of the more recent uses of electricity are hearing aids, television, and electric blankets. Even in places where power lines do not reach, electricity is tremendously important, as in automobiles, tractors, combines, and other machines.



Electric floodlights used to light a baseball stadium at night.

NOTE: The photographs used to illustrate this chapter were made available through the courtesy of the Canadian General Electric Company.

So many common things around us are operated by electricity, we sometimes do not think much about them. But suppose there were no electricity! How we would miss our favorite radio programs. We would have to do without automobiles, telephones, electric lights, gas engines, tractors, and many other things. How long a list can you make of things we would not have if we had no electricity? Your list will help you understand how important electrical power is.

One Way to Produce Electricity

Have you ever observed sparks as you stroked a cat's back in the dark? Have you ever heard the crackle of electricity as you combed your hair? Sometimes, especially in the winter when the air is dry, we play a trick on our friends. We rub our feet on the carpet, then touch our friend's ear. How surprised he

A stroke of lightning photographed at night.

is when a tiny spark of electricity jumps from our finger to his ear! In each of these instances, we have produced electricity by rubbing or friction. Electricity produced in this way is called *static electricity.*

Briskly rub a comb or a fountain pen on your coat sleeve. Then try to pick up small bits of paper. The attraction you observe between the pen and the bits of paper is due to a charge of static electricity which the rubbing produced on the pen. This experiment is usually most successful in cold, dry weather during the winter.

Nature also produces huge sparks of static electricity. We call these great sparks *lightning.* Lightning, as you know, can do much damage.

How Is an Electric Current Produced?

Many of us have used a flashlight. What produces the light that comes so readily when we push the button? What source of power is there inside the outer case of a flashlight?

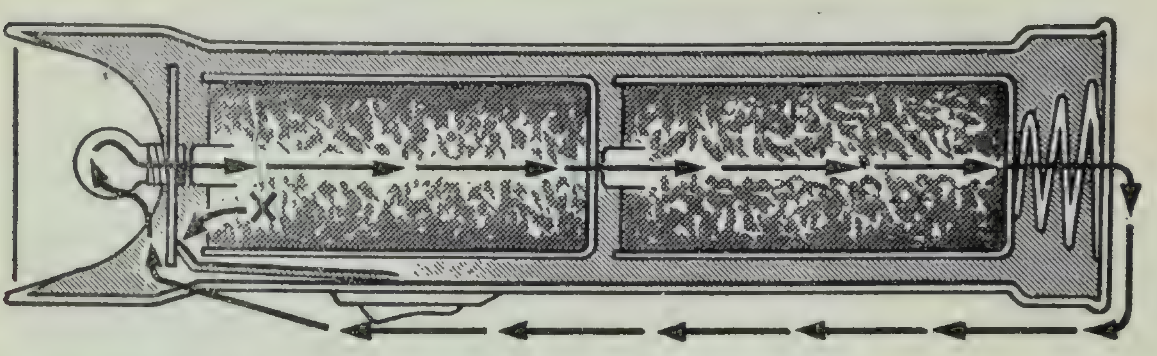
Let us proceed to find out what conditions are necessary to produce a flow of electricity.

How Is Electricity Produced in a Dry Cell?

PROBLEM: *How does a flashlight battery (or dry cell) produce an electric current?*

We can learn a great deal about electricity by examining a flashlight. BE SURE TO HAVE ONE ON HAND FOR THIS STUDY.

FIRST: On the outside of your flashlight, notice the switch which can be moved back and forth. Perhaps you can see in your flashlight, or by examining the diagram on the next page, that the outside part of the switch is attached to a metal strip inside the flashlight. Can you see, too, that this metal strip must be pushed forward so that it touches another part of the flashlight before light is produced *or* in other words before an electric current is produced?



The parts of a flashlight. Trace the path of the electric current (the electric circuit)—follow the arrows. The point marked X shows where the circuit is broken, by pushing back the switch, to stop the electric current when it is desired to turn out the light. What happens if there is a break in any other part of the circuit?

The path followed by an electric current is known as an *electric circuit.* The first thing to learn about producing an electric current is that there must be an *unbroken* circuit through which it can flow. The diagram will show you the circuit followed by the electric current in a flashlight. Follow the arrow. *Trace the circuit on your own flashlight.*

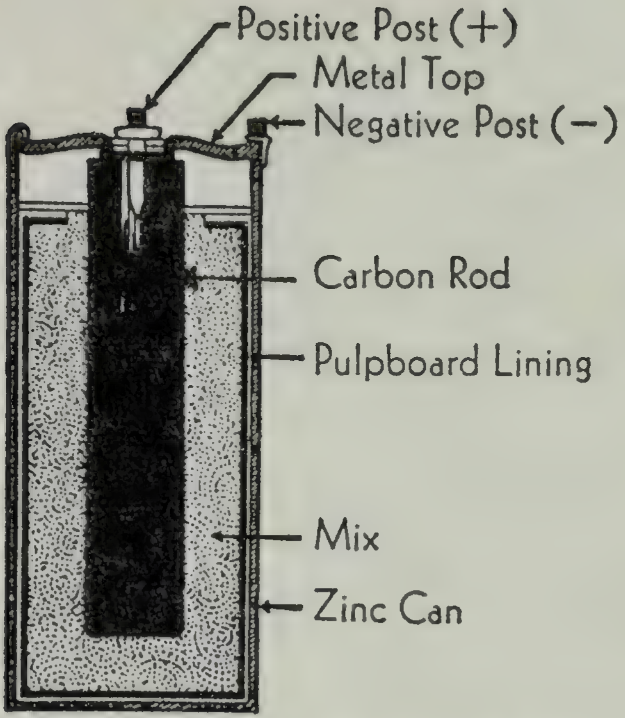
To turn out the light, or in other words to stop the electric current, the switch must be pushed back so that there is a break in the circuit. See X in diagram.

SECOND: Let us find out how flashlight batteries produce electricity. (NOTE: The batteries in a flashlight are like all *dry cell* batteries.)

Secure a worn-out flashlight battery (or other dry cell). Using a hammer and a chisel cut open one side of the metal container and spread it open. Find the following parts:

Zinc container.
Carbon rod or post, in the centre.
Positive and negative posts or terminals.
Black mix or paste, between the zinc and carbon.

Sonia Kosinik



A dry cell cut open to show how it is made. Explain how the electric current is produced.

How is the electric current produced? The black paste contains a chemical (ammonium chloride) which slowly acts upon the zinc container. Part of the ammonium chloride and the zinc combine and a new substance is formed. As a result of this chemical action, an electric current is produced. The carbon post is called the positive pole and the zinc the negative pole.

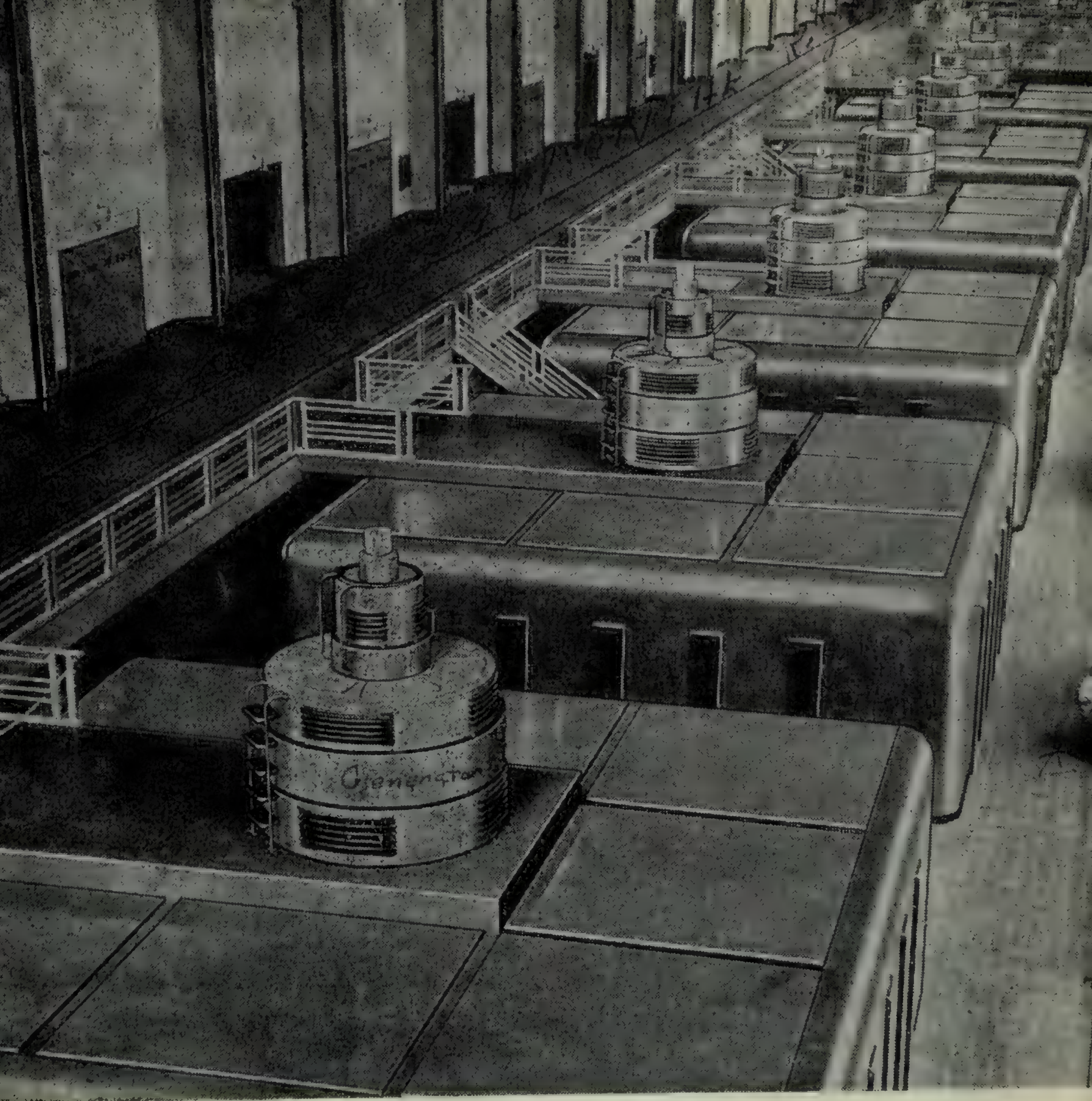
A dry cell is not really dry. The chemical mixture or paste is moist, and is prevented from drying out by sealing tightly the top of the zinc container. A dry cell will stop delivering electric current when the paste dries out or the zinc is eaten away.

Dry cells are used for many purposes, as, for example, to operate electric bells and some kinds of telephones.

Dry cells have a limited use because they cannot be renewed. Another kind of battery, the *storage battery,* can be recharged when it becomes weak.

Electricity Produced By Generators

From where does the electricity used in our homes come? Let us find out.



A large generating station. Note the man at the right.

If you live on a farm, you may have an electric lighting plant in the basement of your home or a wind-operated generator. Ask your father to explain to you, *in a simple way*, how the electricity is produced. Report to your class.

If you live in a town or city, wires will extend from your home to a *power house* either in your town or in another town which may be many, many miles away. A power house is a large, interesting place. In it are

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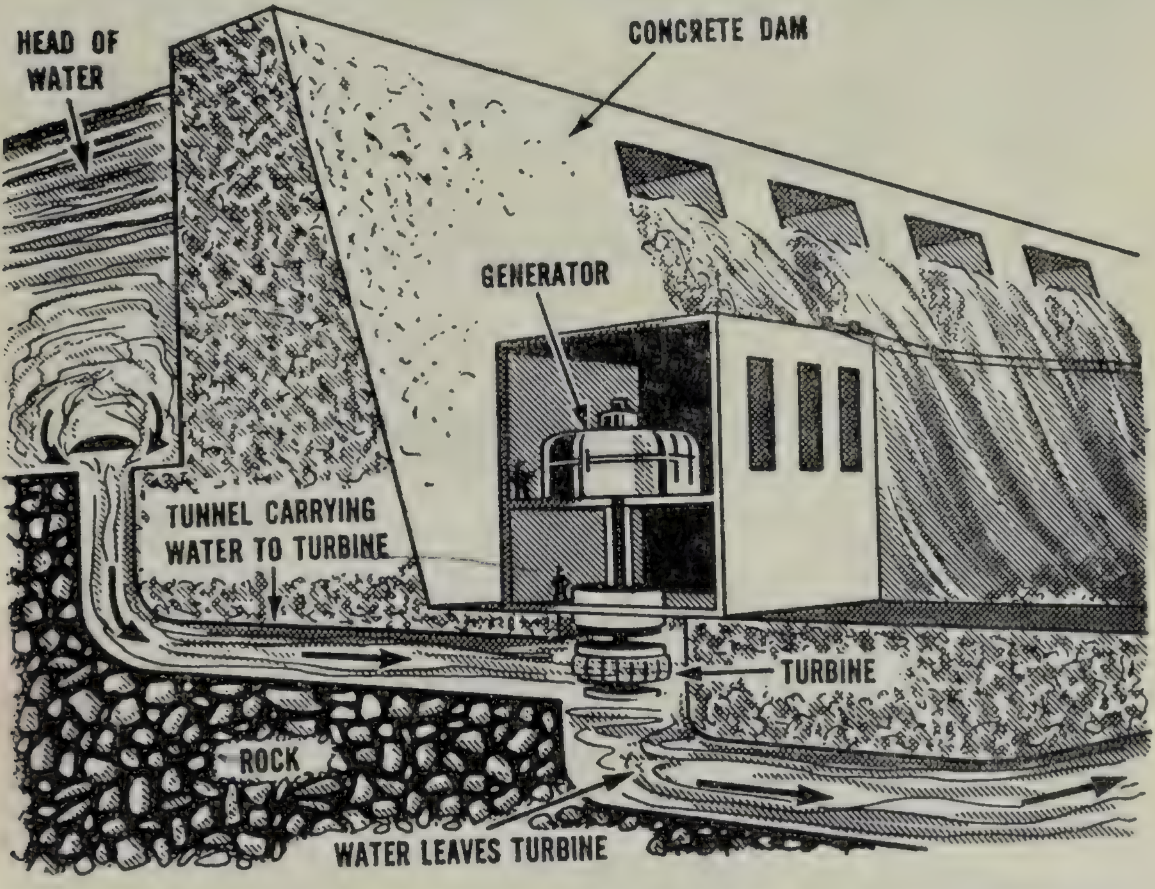
huge *dynamos* or *electric generators* which produce electricity. In a generator, *magnets* and *wires* are so arranged that by turning one part of the generator an electric current is produced. The force required to turn the generator may be developed in several ways.

When swiftly *running or falling water* is available each generator in a power house is connected by a rod to a *turbine.* A turbine is a wheel that has slanting blades. It may look something like a pin-wheel or windmill, and works in much the same way. When a powerful stream of water is forced against the blades of the turbine, they turn around and around very swiftly. As the turbine turns the generator also turns



This diagram shows one way of using the force of swiftly moving water to turn a generator to produce electricity. Only a part of the water stored behind the dam is required to operate the turbines in the powerhouse. The rest pours over the spillway at the right.

rapidly (several hundred times a minute). By means of generators large amounts of electricity are produced, and sent through the wires of power lines to places often hundreds of miles distant.

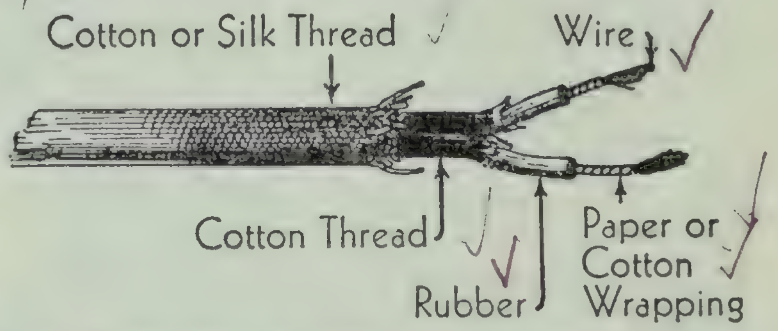
Many power houses use coal or oil to change water into *steam*. The steam is forced against the blades of turbines which turn the generators.

Wind harnessed by means of windmills, and *burning fuel* in gasoline and diesel engines are also used to provide the power required to produce electricity.

Summary: In all the cases we have just considered, the energy or force of moving water, steam, or wind, or of burning gas in engines is changed into electrical energy.

In dry cells and storage cells, energy released by chemical action is changed into electricity.

Using Electricity Safely



This illustration shows the ends of the two wires in an electric light wire. Why are the wires so thoroughly covered (insulated)? What kinds of coverings are used?

Strong wires carry the electricity from the power house to our homes. These wires must be placed high over our heads or underground to protect people and passing animals. Sometimes the wires are covered with rubber which prevents the electricity from escaping from the wire. These measures to protect people are necessary as a strong current of electricity

In this modern kitchen, electricity is used to operate the electric stove, kettle, mixer, coffee maker, toaster, refrigerator, lighting (not shown), and the heating and ventilation system.

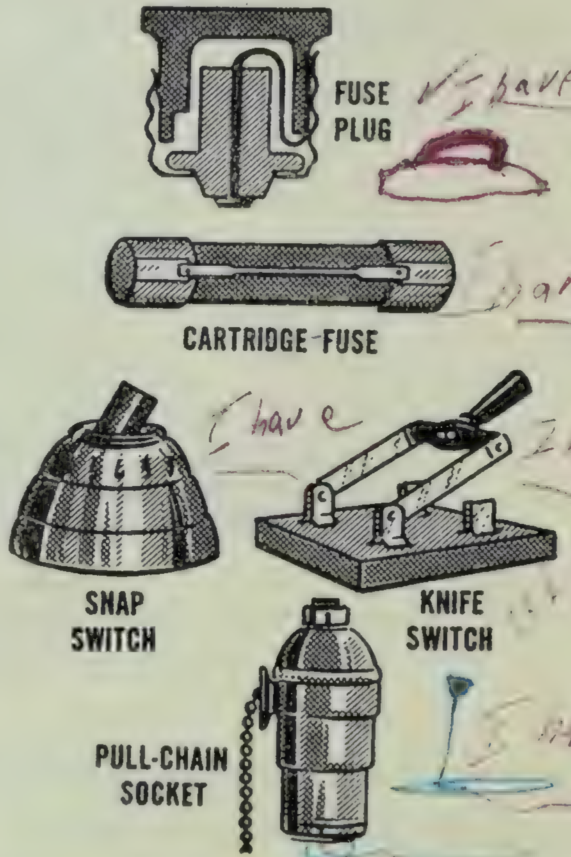
can hurt us very much or start a bad fire. Electricity cannot pass through rubber.

In our homes, smaller, lighter wires are used to carry the electricity to our lights, stoves, toasters, and other things which it operates. These wires are also covered with rubber and silk or cotton to prevent the electricity from escaping. We should watch carefully the coverings on electric cords or wire connections which we use in our homes. If a bare spot occurs, the electricity may hurt someone who happens to touch the wire at that spot. Never use a badly worn electric cord. Never touch a broken electric wire out-of-doors. It pays to be safe where electricity is concerned.

How Is Electricity Controlled?

As we learned in our study of the dry cell, an electric current flows through a path or *circuit.* If for any reason a break occurs in the circuit, the electric current stops immediately. To start the electricity flowing again, it is necessary to close the break in the circuit.

Electric *switches* have been made to make it possible to easily close and break electric circuits, or as we often say "turn on" or "turn off" electricity. Turn a switch one way and the circuit is closed. Turn it the other way, and the circuit is broken.

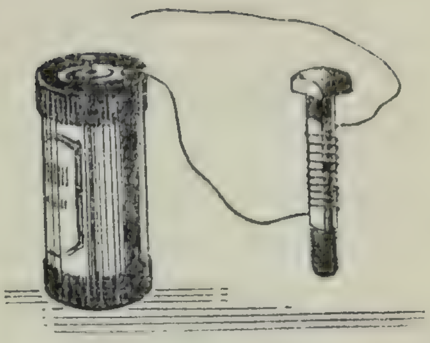


Electric *fuses* are safety devices placed in electric circuits. If for any reason the current should become too strong and likely to heat the wire and cause a fire, a part in the fuse melts and breaks. The flow of the dangerous electric current is thus stopped.

How to Make an Electromagnet

The telephone bell and other electric bells include a very important part called an *electromagnet.* You can easily make an electromagnet as follows:

Neatly wind about 3 feet of bell wire or other fine, insulated electric wire around a soft iron bolt. Attach one end of the wire to a terminal of a dry cell—carefully remove the coverings from about ¾ inch of the end of the wire before attaching it to the terminal. You now have an electromagnet ready to operate.


What must be done to give the iron bolt in this illustration power to pick up small pieces of iron and steel.

Touch or attach the other end of the wire (covering removed) to the other post or terminal of the dry cell. Try to pick up small nails or tacks with the soft iron bolt. It has become magnetized. Disconnect one end of the wire from the dry cell and observe what happens to the tacks or nails that were lifted up by your electromagnet. The soft iron bolt is a magnet only when both ends of the wire are connected to or touching the terminals of the dry cell. As soon as one end of the wire is disconnected the electricity stops flowing through it. When the electricity stops flowing through the wire, the iron bolt loses its magnetism. Do not leave the electromagnet connected up for more than a few seconds; if you do you may damage the dry cell.

A huge electromagnet lifting great pieces of iron.

Electromagnets have many uses. There is one in the loud-speaker of your radio and in the receiver or ear-piece of your telephone. Large electromagnets are used to lift heavy pieces of iron and steel. The stronger the current, the heavier the load an electromagnet can lift.

Problems and Things To Do

1. List and briefly describe or discuss ways in which electricity is used:

In transportation. ✓
In communication. ✓
In the home. ✓
On the farm. ✓
In a factory. ✓
In a hospital. ✓
In an automobile *or* a tractor. ✓

2. Prepare a booklet or a set of charts illustrating the uses of electricity. Collect suitable pictures. Usually *one* picture of each use will do. Be able to describe the use each picture illustrates.

3. What kind of electricity is produced by friction?

4. How do we protect buildings from lightning? Examine the lightning rods on the school.

5. How is electricity produced in a dry cell?

6. Visit a garage or service station. Ask to be shown a storage battery and how it is recharged.

7. Find pictures of big power houses and electric generators.

8. Examine a generator on a bicycle. It is a little brother of the huge dynamos at the powerhouse.

9. Try to make a toy electromagnetic crane.

10. Listen to the telegraph instrument at your railroad station. It is operated by means of an electromagnet. Name some other machines that use the electromagnet.

11. What is the purpose of an electric switch? Explain how it operates.

12. How does a fuse protect an electric circuit from becoming too hot?

This is a picture of the earth as it appeared 400 million years ago. Two animals of that time are to be seen near the lower right hand corner—they have long straight shells. (Illustration by courtesy of G. A. Reid and Royal Ontario Museum.)

THE STORY OF OUR EARTH

The story of the earth extends over a period of many, many years. Some scientists believe that the earth, upon which we live, is over two thousand million years old.

What Was the Earth Like at First?

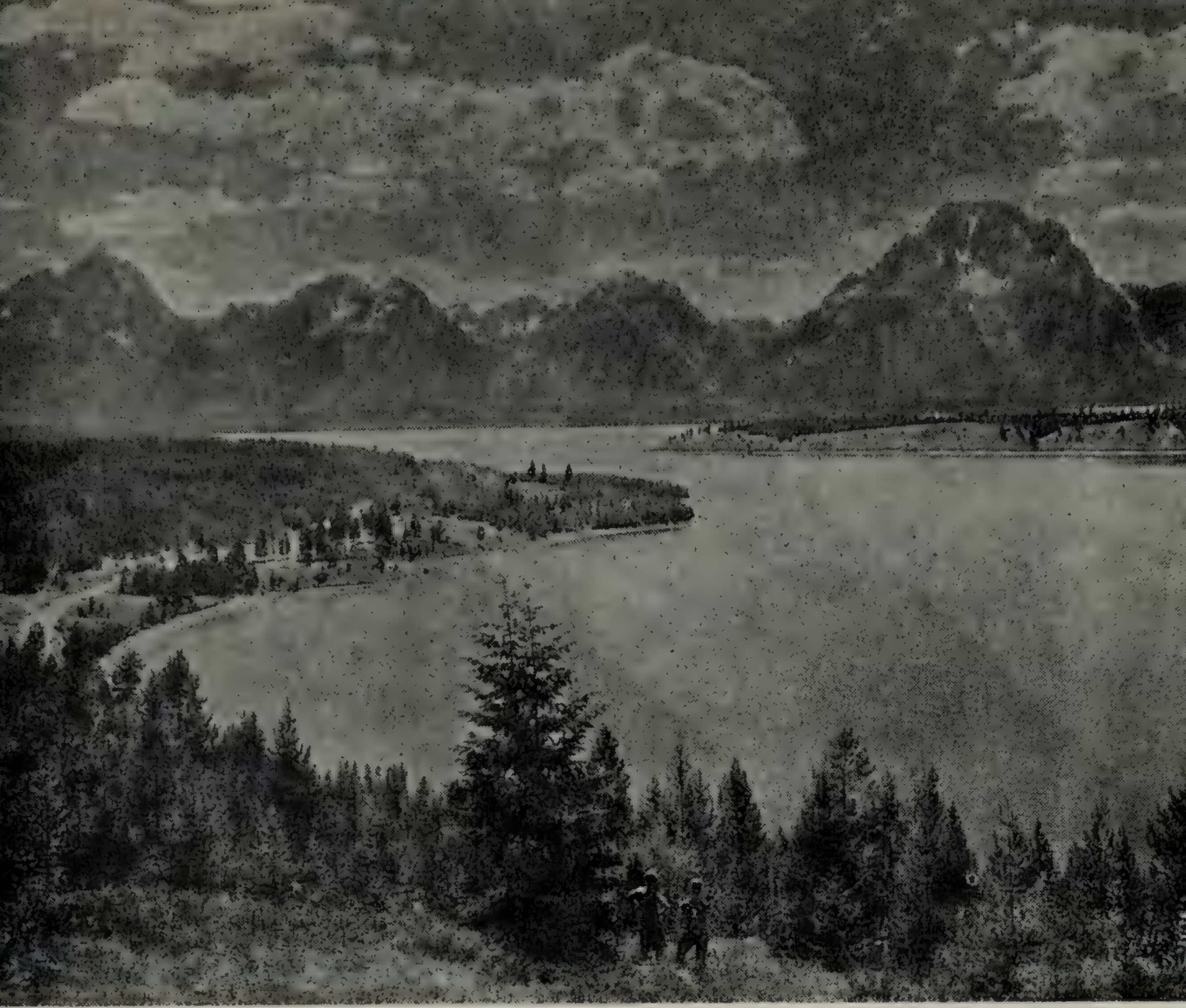
It has been millions of years since the gases, which were separated from the sun, were cooled to form the solid parts of the earth. Can you imagine a world with no trees, no grass, no flowers, no houses, no people, no dogs, or no birds? Such a picture will give you some idea of the earth as it was in those far-away days. Towering masses of solid rock and great boiling seas covered the surface of the young earth, which was very hot. At first, there were no living things, but after a long time animals and plants appeared. The first plants and animals were very different from the familiar ones of the present time. What a strange world it must have been! What changes have taken place to produce the world as we know it now!

The Changing Surface of the Earth

The surface of the earth has changed its appearance many times. The continents and oceans were not always located as shown in the maps of today. The outer part of the earth has wrinkled and changed just as the peeling of an apple wrinkles and changes as the apple dries up. Many times the land under the seas was pushed up to form mountains, and the peaks of mountains have sunk into the sea or been worn down and carried to the seas by rushing rivers.

One author of this book once found near Regina a piece of rock in which were fossils of small animals that lived in the sea 200 million years ago. This piece of rock was formed in northern Manitoba. How had it been carried to southern Saskatchewan? The answer is that hundreds of years ago, during a time known as the Ice Age, it was picked up and transported over the land by a huge sheet of ice called a glacier. This sheet of ice was so thick from top to bottom that many grain elevators piled one above the other would not have reached to the top of it. It caused many changes in the surface of our country.

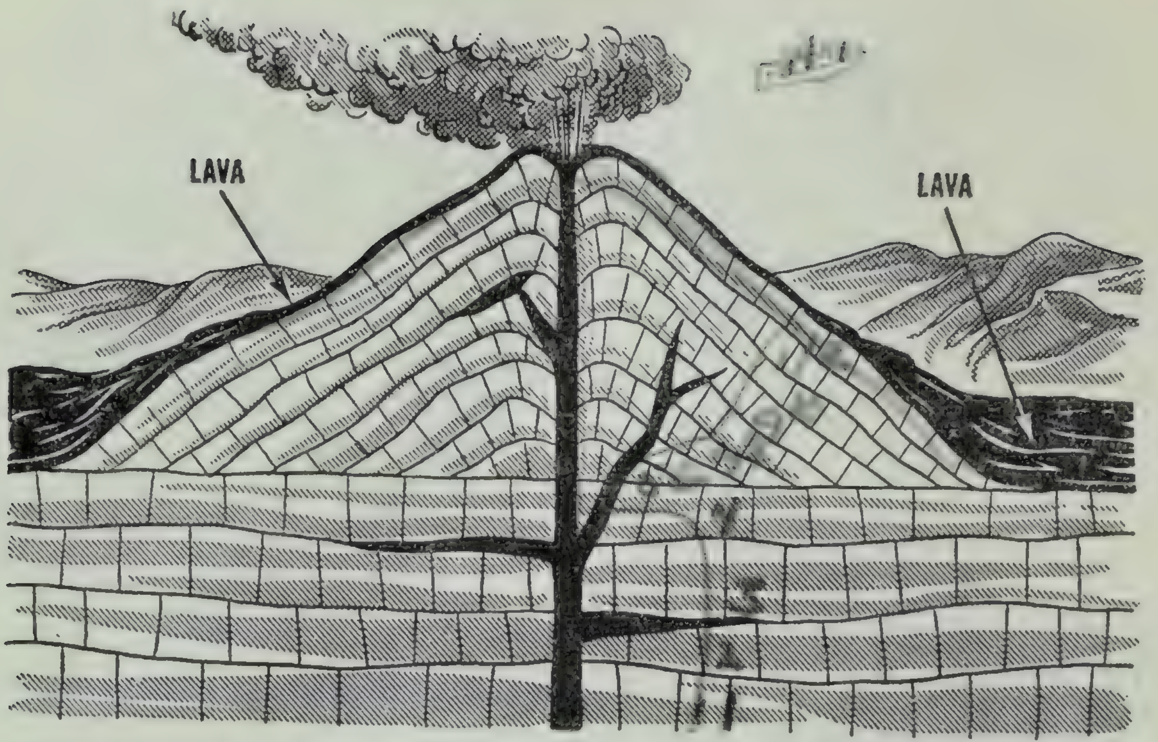
As we think of these things we can realize the changes that have taken place in the surface of the earth since the time during which it was formed. It is important to remember, too, that the surface of the earth is still changing. It is not the same today as it was a year ago. By next year, other changes will have taken place.



The surface of the earth varies greatly. In some places it is a level plain. Other parts are great mountains reaching high into the sky. Much of it is covered by water.

The Age of Volcanoes

When the solid outer part of the earth was first formed, the inner part was still very hot. It was so hot that some of the rocks in the inner part melted. Some of the molten rock material pushed up through weak spots in the earth's surface and flowed out over the land. There were many, many such volcanoes in existence at that time. There are still volcanoes in the world that break open on occasion and pour molten rock, or lava, and hot ashes over the surrounding areas. Sometimes the lava flows out slowly and quietly. At



This diagram shows a volcano with part of it cut away. Notice how the lava flows up through the centre, and spreads over the surface around the volcano as shown at the right of the drawing.

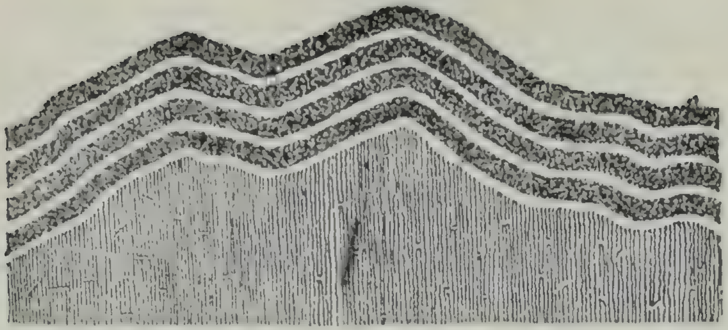
other times great clouds of water vapor and ashes are thrown out with a loud roar.

During that early period, so many million years ago when volcanoes were so numerous, there was no air and no water. Many years passed during which the air and the oceans gradually formed.

How Mountains Were Formed

A grain elevator is high. But a mountain may be one hundred times as high. How have the great masses of rock which form the mountains been raised so high?

Many mountains were formed by the action of volcanoes. Great masses of lava poured out and cooled to form solid rock. Then more lava flowed from the volcanoes and cooled. Gradually towering piles of rock, or mountains were formed.



This illustration shows how mountains were formed by the wrinkling of the earth's crust.

Other mountains were formed by the wrinkling or bulging of the rocks in the earth's crust. As these movements in the earth's surface took place, huge masses of rocks were pushed up to great heights. The Rocky Mountains along the west coast of North America were formed in this way.

How Rocks Were Broken Up to Form Soil

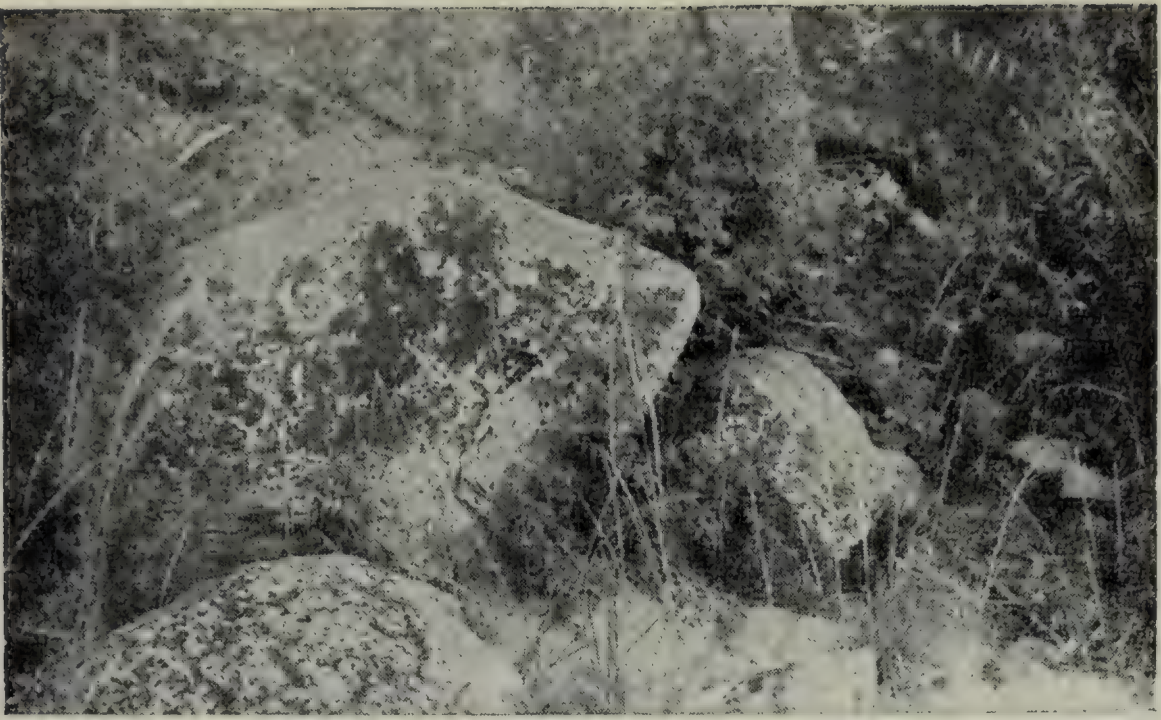
As soon as the rocks were lifted up to form mountains they began to wear away. Both the lifting and the wearing away processes were very, very slow. If there are rocks near where you are living, you may find it difficult to realize that they, too, are slowly, slowly being changed into soil. Nevertheless, that is exactly what is happening. Even the tallest mountain gradually becomes lower and lower as it is worn away.

Did you ever stop to consider just how important the soil is? It has been described as our most precious possession. Very many parts of the earth are covered with a blanket of soil. Grass grows in soil. The trees of the woods grow in soil. Crops grow in soil. Without soil there would be few plants of any kind. Without plants there would be no food for the animals, and therefore no animals. It is not necessary for us to think very long about it, before we realize that without soil many forms of life would be impossible. This very important fact and the fact that soon spring will be

These rocks have been worn away by the action of the waves of the ocean. Each year the rocks become a tiny bit smaller. (Canadian National Railway photo.)

here and gardeners and farmers will be preparing for another seeding time suggest that it is worth our while to learn a little about the soil.

What is soil? Long, long ago when the earth was young there was no soil. For millions of years the earth was bare rock, but very slowly changes took place. The rocks were broken up into very small particles. Then tiny, tiny plants found a way to grow in the rock particles and on the larger pieces of the rocks. When these plants and later other plants died, their bodies decayed and became mixed with the rock particles.



Even today there are plants that grow on rocks instead of in soil. The dark spots on the rocks in this picture are tiny plants called *lichens* (pronounced li′ken). You can find lichens on many rocks. Some are black in color. Others are orange.

When this had happened soil was formed. When animals die their bodies, like those of plants, decay and help to form soil.

Soil is chiefly a mixture of pulverized rocks and decayed plant and animal material.

An exercise. Spread samples of soil thinly on a sheet of paper. Examine them closely, using a magnifying glass if possible. You will be surprised to see the many tiny rock particles which compose the soil. They are many colors—red, green grey, white. Some will shine like glass. Others will be dull in color. They will vary greatly in size, too. Scattered throughout the rock particles you will find specks of a black, softer looking material. This is the decayed plant and animal material. It is called *humus*.

How were the rocks broken up? Some rocks are very hard. You can hardly break them even with a hammer. What is strong enough to pulverize the rocks into fine grains of soil?

Water and wind are always at work grinding up the rocks. Other agencies, too, such as the sun, plants and animals, and several more are also important in the process of forming soil.

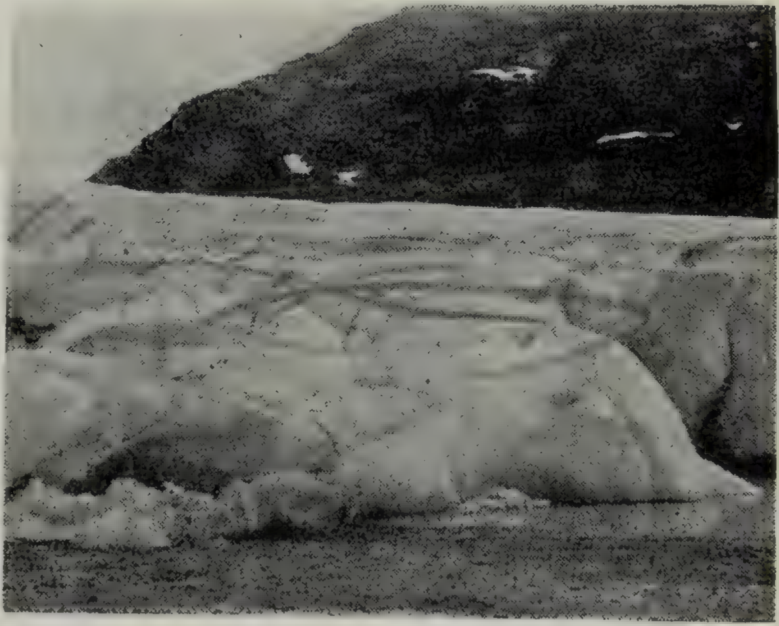
Water helps in several ways to break up the rocks. Along the sea and lake shore the powerful waves pound on the rocks and finally smash them to pieces. Rocks along the shore are rolled over and over each other by the waves until they wear away. Sand is rubbed against the rocks and acts like sand paper, slowly changing the huge solid rocks into tiny particles of soil. In the beds of rivers, the same process goes on, until the rocks are ground and cracked and rubbed and pounded into small grains. All the pebbles and sand were once parts of great high rocks. Water also dissolves material in the rocks, so that they crumble and fall apart.

In the foreground of this picture is a glacier. Higher in the mountains are huge piles of snow. As the snow piles up, the lower parts are packed so hard they form the ice which makes the glacier.
(Photo by Dan McCowan.)

When winter weather comes, there is often water lying in the cracks and hollow places in the rocks. Then the water freezes and the big rock is broken into smaller ones. We know that freezing water has enough power to break things. After a long time a pile of small stones is left where once great rocks stood. Finally soil particles are formed.

Many, many years ago, Canada and the northern part of the United States were covered with a huge sheet of ice, called a *glacier*, which flowed with unbelievable slowness towards the south. This moving sheet of ice weighed tons and tons, and like a huge roller, it crushed and ground and rubbed the rocks against one another, breaking them up into small soil particles. Then the ice picked up the soil and often carried it far from where it was formed. This huge glacier has long since almost entirely melted and disappeared, but the soil in many parts of Canada was formed by glacial action. Glaciers still slide down the sides of mountains grinding the rocks into soil and transporting soil material from one place to another.

The *wind*, too, is a great helper in making soil. It blows sand and soil particles against the rocks, thus wearing them away. Then the wind picks up the tiny rock particles it has helped to form and carries them to another part of the country. The wind is still at work blowing soil. In many places the problem of preventing the soil from



This shows the front of a glacier as it flows down a mountain valley. As it reaches the warmer, lower levels it melts. (Photo by Dan McCowan.)

blowing away is one of the greatest problems of the farmers.

We have learned that *plants* help to make soil. In the woods the soil is rich and black because there is an abundance of decayed plant material or humus in it. Dark colored soils are usually rich in humus. Plants also help in another way in the process of soil making. Their roots grow into cracks in the rocks and as they become larger, pry the rocks apart.

Animals, too, help to make soil. When the animals die, their bodies decay and add humus to the soil mixture. Burrowing animals, such as gophers, make openings in the soil so that air and water can penetrate and carry on their work of soil making. The digging operations of these animals also stir and mix the soil particles. Everyone knows the reddish-colored earthworm, or fishworm as it is called by the folks who like to use it for fish-bait. These animals are important soil makers. They eat the soil and as it passes through their bodies, the soil particles are broken up into still smaller particles. Tons and tons of soil are carried from below to the surface by the earthworms. Earthworms and good soil are usually found together.

And so we learn that many agencies help to grind the rocks into soil. Remember this—the process is a very slow one. Years and years and years pass while the wind, the water, the glaciers, the plants, and the animals are wearing the rocks into particles and building up a supply of humus to make the soil. Without a plentiful supply of decayed plant and animal material in it, a soil is of little use to growing plants. Good gardeners are careful to keep their soil well enriched with humus. But this is a story we must consider later.

Questions and Things To Do

1. Tell briefly in your own words the changes that have taken place in the surface of the earth since it was first formed.

2. Why do people observe so few changes in the surface of the earth, even during a whole lifetime?

3. Plan a Nature hike some day for the purpose of looking around in your district to find places where wind and water are causing changes.

4. Look for a picture of a valley between mountains. Explain two possible causes for the difference in height of the bottom of the valley and the tops of the mountains.

5. How do volcanoes help to build up mountains? At what time in the development of the earth were volcanoes very numerous?

6. Tell briefly about the Ice Age. How did the glaciers change the surface of the earth?

7. If you live on the prairies, try to form a good picture of a mountain in your mind. How were mountains formed?

8. Show how all life depends upon the soil.

9. On a rainy day, watch the water rushing along in small rivers. Notice the soil it carries along. Observe how the soil particles roll over and over one another. Do you think they are being worn away as they are carried along in the water?

10. Try to make soil from stones. Rub a hard stone against a soft one. You can make a little pile of soil in a short time.

11. Of what is soil composed?

12. What is humus? What is its value in soil?

13. Bring samples of different kinds of soil to school. Try to find a very sandy soil and a clay soil. Bring soil from the garden and some from the woods. Examine your samples carefully. Which are composed of fine particles and which of coarse? Which are dark colored and which light in color? Which are rich in humus and which are not? Of the soils you collected which kind do you think people would like best to have in their gardens? Why?

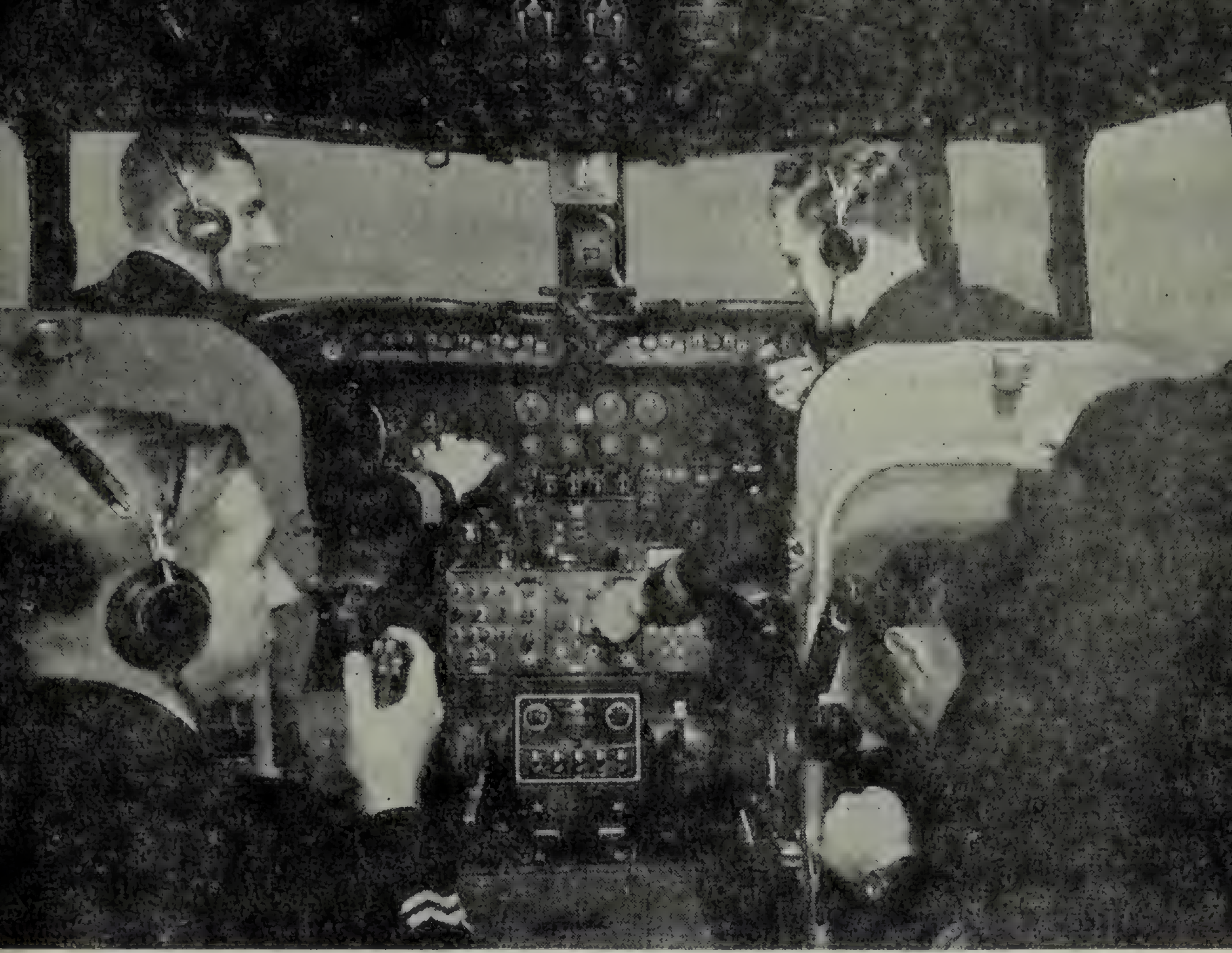
A Trans-Canada Air Lines North Star airplane which can carry 40 passengers at a speed of more than 300 miles per hour. Its four engines have a total of more than 7,000 horse-power.

HOW DO AIRPLANES TRAVEL?

Men were a long, long time learning how to build a machine that would fly. It was on December 17, 1903, that the Wright brothers made the first successful airplane flight.

The airplanes of the present are marvelously constructed. Under ordinary conditions they carry

NOTE: The photographs used to illustrate this chapter were made available, except where otherwise acknowledged, through the courtesy of Trans-Canada Air Lines.



The flight deck of a T.C.A. North Star. Seated at the controls are the *Captain* (left) and the *First Officer* (right). On overseas flights a *Radio Officer* (left foreground) and a *Navigating Officer* (right foreground) are added to the flight crew.

passengers, freight, and mail speedily and safely. Their bodies are streamlined to reduce the resistance they offer to the air. Some planes travel faster than the speed of sound. (See also page 184.)

How Does an Airplane Fly?

First, we must understand and remember that air is a real substance. We cannot see it. Nevertheless, it has weight and presses with considerable force against objects in it.

Two forces operate to keep an airplane in the air:

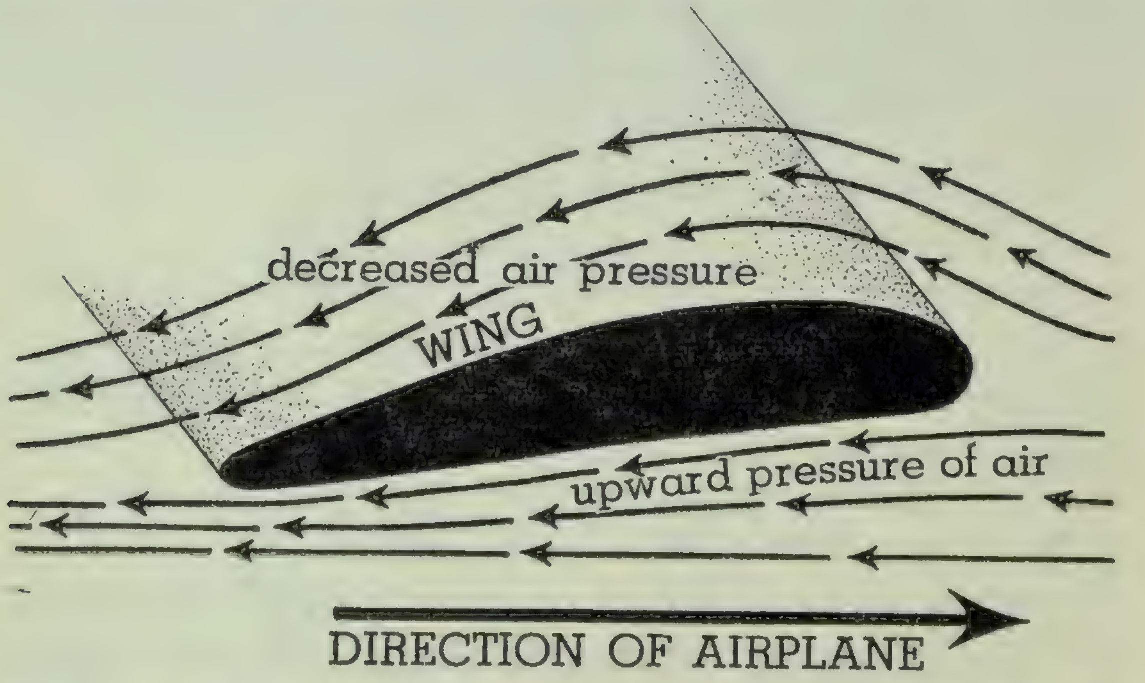
1. As the propellers pull the plane through the air the air pushes upward against the slanting

under-surface of the wings. The result is the wings of the airplane are pushed upward.

2. To help us understand the second force, let us perform a simple experiment.

EXPERIMENT: Secure a long, narrow strip of paper (one inch by 12 inches). Holding the paper in one hand blow along the *top* surface. What happens?

Why does the paper rise to a horizontal position when you blow along the top? The answer is that as you blow, the air moves faster along the top of the paper than along the under side. This causes the pressure of the air above the paper to be less than the pressure of the air below it. Therefore, there is a greater pressure of air upward against the paper than there is downward. As a result the paper rises.



This diagram represents a section across the wing of an airplane. Because of the shape of the wing, the air above it moves faster than the air below it. The pressure of the air flowing over the top of the wing is less than the pressure of the air below it. The force that holds the plane up (known as *lift*) is largely the result of the difference between the air pressure above the wing and the air pressure below it.

Now, let us think about an airplane wing. Notice in the diagram that the upper surface is curved, while the lower surface is flat. When an airplane is in motion, the air flows faster over the curved top surface of the wing than the air below the wing. As was the case in our experiment with the strip of paper, the pressure of the air above the wing is less than the pressure of the air below. The result is an upward pressure against the wing.

As you know, the force that keeps an airplane on the ground is the pull of *gravity*. To raise an airplane into the air and keep it in flight, it is necessary to

A *helicopter* can rise straight up or land straight down. It can fly forward, backward, sideways, or remain still in the air. It has no wings, but is equipped with a set of large rotating blades. A small propeller on the tail helps in steering. (United Aircraft Corp. photo.)

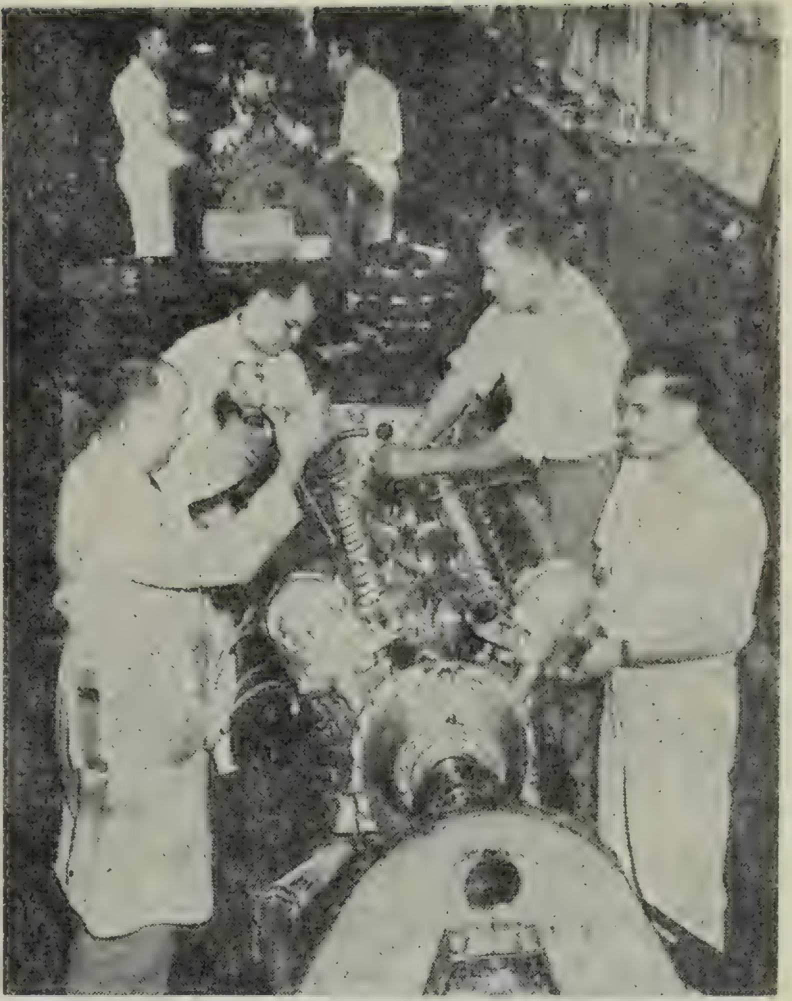
In glass-enclosed towers, like this one atop an airport terminal building, airport controllers radio landing and take-off instructions to arriving and departing aircraft.

produce an upward pressure of air that is greater than the downward pull of gravity.

How Is an Airplane Operated?

Examine the airplane instrument board in the photo on page 131. It has a great many instruments. Some of these are: the *air speed indicator* which tells the speed the plane is travelling through the air, the *altimeter* which indicates the height of the plane, the *compass* to show direction, and *gauges* to show fuel supply, engine temperature, engine speed, oil pressure, outside temperature and other things the pilot must know to operate his plane.

If possible, the pilot always takes the plane off the ground and lands into the wind.

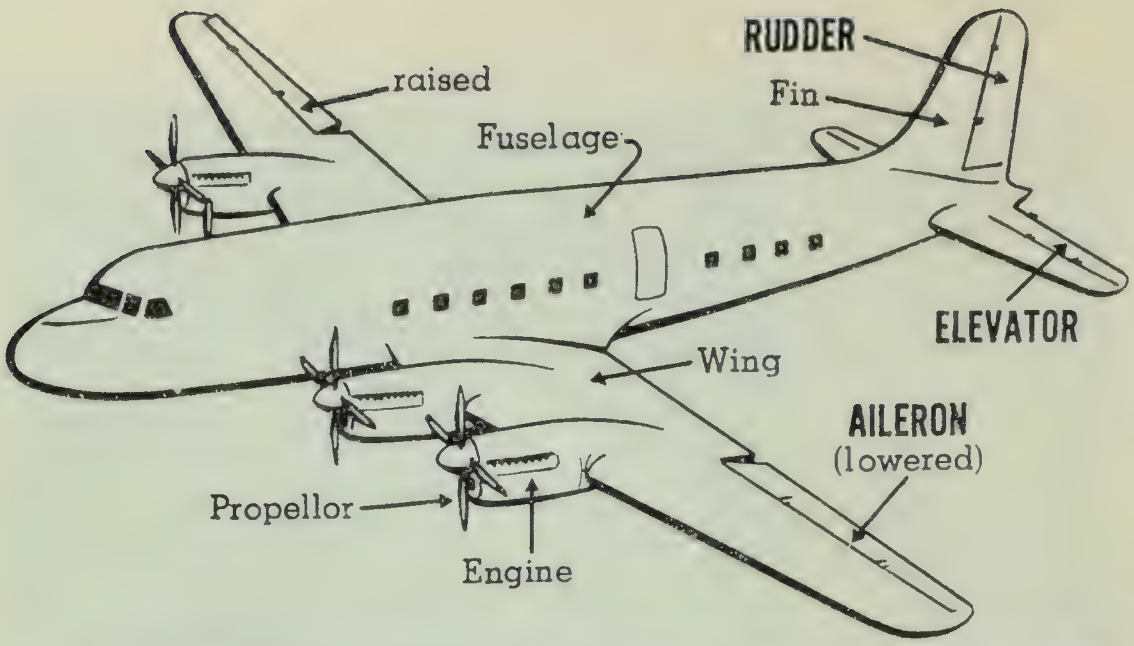


Highly trained men overhaul an airplane engine. The engines must be kept in good condition so that they will not fail when the plane is in flight.

The *rudder* (see diagram on page 136) is operated by two pedals which the pilot works with his feet. As the rudder is moved to the right or to the left, the plane is made to turn right or left.

The *elevators* (the horizontal, movable parts of the tail) are raised or lowered by means of the *stick*. The stick is a lever that is operated by the pilot. When the elevators are turned up, the tail of the airplane is forced down and the plane turns upward. When the elevators are turned down, the tail of the plane rises and the plane turns downward.

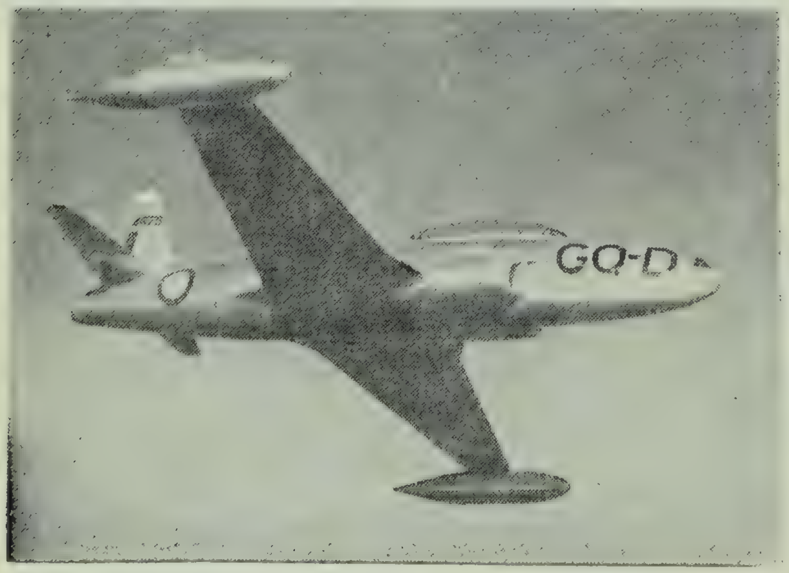
The *ailerons* are movable parts at the rear edges of the wings. They are used to tilt the plane to the



The parts of an airplane. The names in capital letters refer to movable parts that are used to steer the plane and to raise and lower it.

Notice in the diagram that the right aileron is raised and the left one lowered. This would result in the plane tilting sideways to the right.

right or to the left. See the explanation under the diagram at the top of this page.



A *jet-engine plane* has no propellers. Air rushing in the front of the airplane is mixed in the engine with fuel and burned. The expanding gases that are formed rush out of the rear of the plane and push it forward. Jet planes have travelled more than 1200 miles per hour. (Dept. Nat. Defence photo.)

A great deal of skill and practice are required to operate an airplane safely.

Problems and Things To Do

1. There may be a boy living near your school, possibly a member of a club, who owns one or more model airplanes. If there is, try to

arrange with him to visit your school to show and explain how his airplane flies.

2. What two forces operate to keep an airplane in the air? Use a diagram to explain at least one of them.

3. Does gravity hinder or help an airplane in flight? Explain.

4. How is an airplane in flight turned upward or downward? Turned right or left? Tilted to the right or to the left?

5. Safety in airplane travel is tremendously important. What steps are taken to make sure that the airplane is as safe as possible.

ARE YOU LEARNING TO DO THINGS FOR YOURSELF?

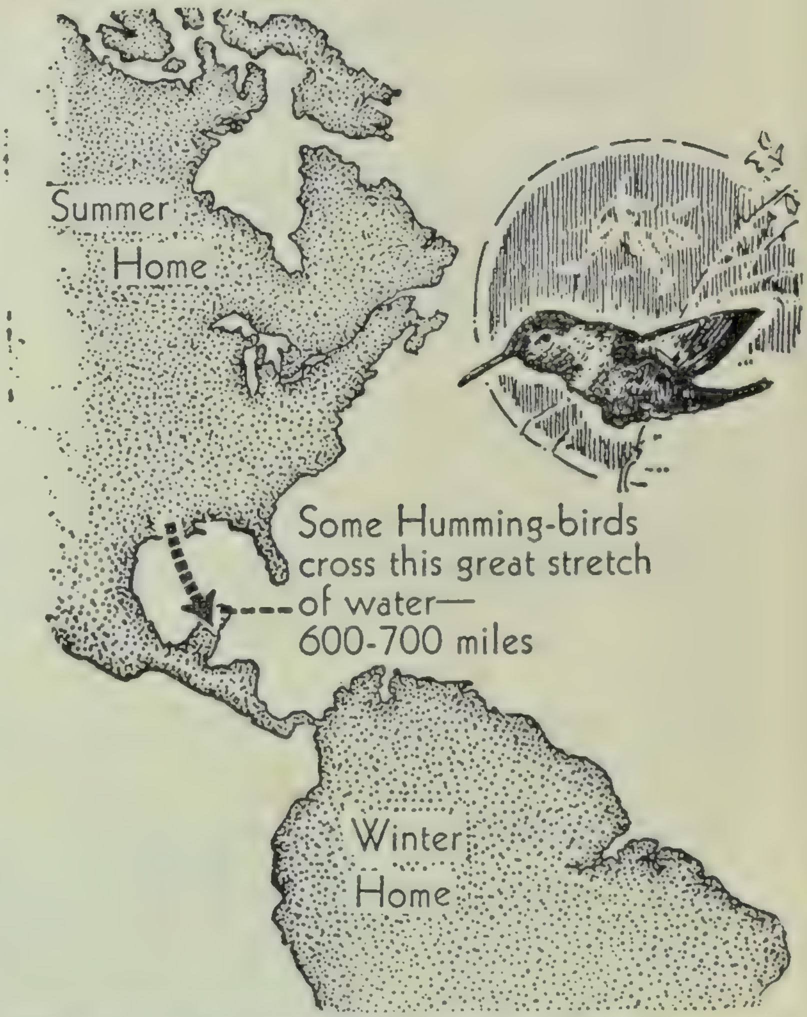
Much of the fun in studying Science is found in doing things for yourself:

- Making your own observations.
- Planning and performing your own experiments.
- Thinking things out for yourself.
- Finding the chief ideas in a study.
- Expressing your ideas accurately.
- Working neatly and carefully.

The great men of science and the inventors of the world were men who were not content just to read about the deeds of others. They wanted to do things for themselves. As a result they made wonderful discoveries and learned many things that have proved to be of great importance to the world.

THE MIGRATION OF BIRDS

People have long known that certain birds disappeared in the fall, but in early times they did not know where the birds went. Many strange stories and explanations were invented. Now we know a great deal about the birds' travels north and south to and from their winter and summer homes. But there are still many things about bird migration that puzzle the scientists who study birds.


Summer Home
Some Humming-birds cross this great stretch of water—600-700 miles
Winter Home

The tiny Humming-bird travels a long distance between its summer and winter homes.

STOP–LOOK–LISTEN: It is important TO LEARN ABOUT THE BIRDS AROUND YOUR SCHOOL AND YOUR HOME.

Watch for birds outdoors.

When you see a bird—stop—stand as still as you can—look closely to see size, shape, actions, color markings.

LOOK FOR THE NAME OF THE BIRD IN A BIRD BOOK.

A bird band is being placed on the leg of this young duck. By this means valuable information about its travels may be found.
(Photo courtesy Imperial Oil's *Happy Motoring*)

Some birds are wonderful travellers. One bird, the Arctic Tern, lives in the far north during our summer and in the Antarctic regions far to the south in our winter time. Many other birds, even the tiny Humming-bird, make long flights each spring and fall.

Scientists have learned about the travels of birds by putting light aluminum bands on the legs of birds which have been caught for this purpose. The bands are marked and dated, and when birds (either dead or alive) with bands on their legs are found, valuable information can be learned about their journeys. It is necessary to obtain permission to catch birds in order to band them.

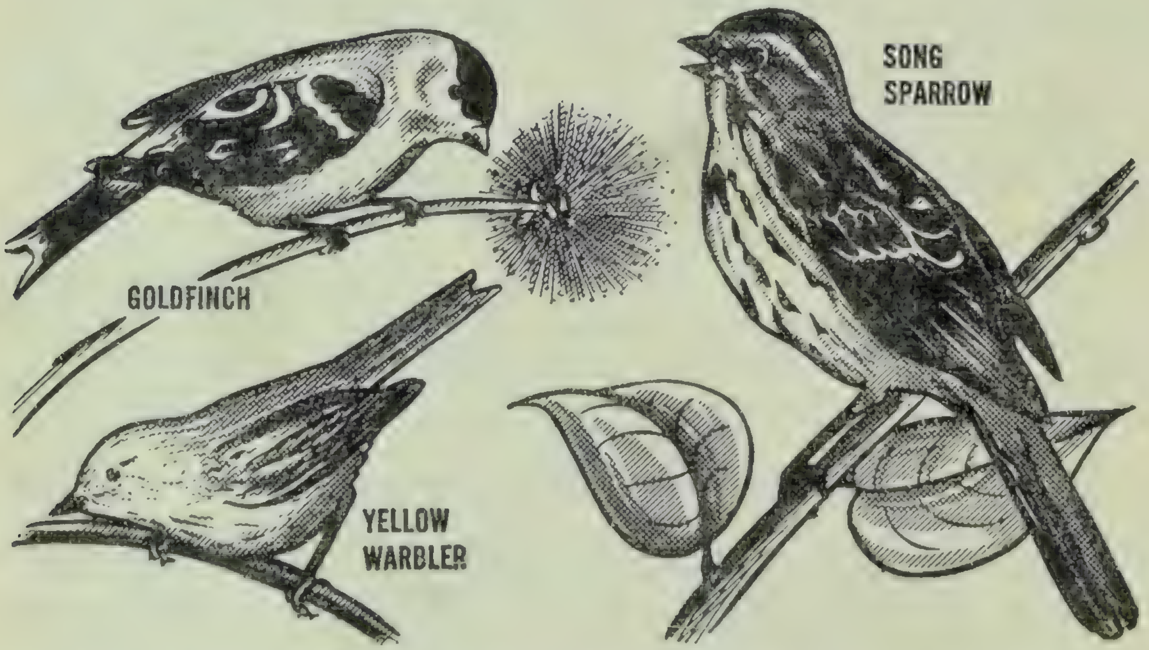
Preparation for Migration—Flocking

During the fall, the migrating birds prepare for their long, dangerous journey south. First, old worn-out feathers are shed and replaced with new ones. After the fall molt (shedding of feathers) the male birds are no longer attired in bright colors, but appear in modest dress much like that of the females. Why is this an advantage during their travels?

During the late summer and early fall, Blackbirds, Crows, Swallows, and many other birds gather in great flocks. They are getting together, apparently to prepare for the journey to their southern homes. Each day they make practice flights, some of considerable distance, just as we do when we are practising for a long race.

Where Do the Birds Go?

Seed-eating birds usually do not go as far south as the insect-eaters. Bluebirds, Robins, Doves, Meadowlarks, and other hardy birds pass the winter throughout United States, often going no farther south than Kentucky or Tennessee. Orioles and Warblers go to Central America, Humming-birds migrate to Brazil, Thrushes



One of these birds leaves very early in the fall. Do you know which it is?

to Peru, and Nighthawks also go to parts of South America. Kingbirds winter in Bolivia and the West Indies.

Why Do Birds Migrate?

Birds know exactly when it is time to migrate, but how they know and why they make the long journey back and forth, are not well understood. Swallows and Warblers go south in August long before cold weather. What tells them it is time to leave? Why do they go?

Scarcity of food, such as insects and seeds, as cold weather approaches or snow covers the ground, is probably an important reason why birds go south. Lack of food seems to be a more likely cause of migration than cold. There is little difference, with few exceptions, between the feather covering of the birds that stay and those that go. Most birds could probably survive the cold if a plentiful supply of food were available. Indeed, ducks and other migrating birds have remained all winter in many parts of Canada when they could secure food.

The reason birds fly northward in the spring is even harder to understand. A desire to return to the place of their birth is one likely explanation. Birds have been known to return to the same place season after season, arriving almost on the same day of the month each year. Another reason may be a desire to escape overcrowded conditions in the south during the nesting season.

"Why do birds migrate?" is a question that still greatly puzzles scientists. Men have been studying the fall and spring movements of birds since earliest times. But they are not yet sure why birds make such long journeys twice each year.

Flyways and Routes Followed

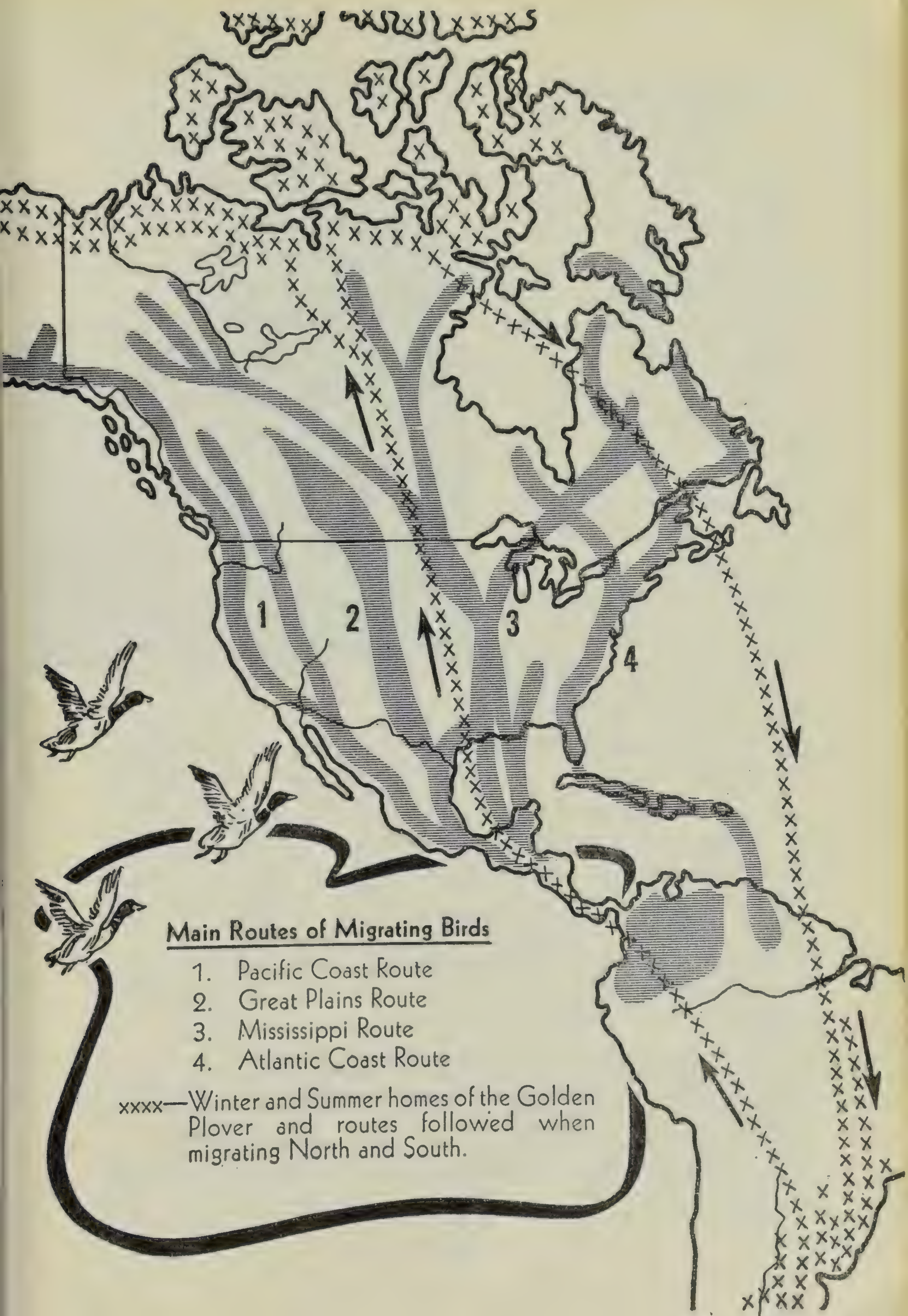
Some kinds of birds follow a narrow migration route. Others travel northward and southward over a wide path. Some routes involve long flights across water. The Golden Plover makes an ocean trip from Nova Scotia to South America. One of the common routes followed is that which takes the birds to the north shore of the Gulf of Mexico, and then across the Gulf a distance of 500 to 700 miles. Even the tiny Hummingbird makes this long water flight on its way to Brazil.

The word *flyway* is used to indicate the migration route from the nesting area to the winter home, and back again. There are four great flyway systems as shown on the map on page 143.

How Do Birds Find Their Way?

Some people believe that birds find their way by following various landmarks. But there are several reasons why this may not be so. First, some birds often fly at great heights. Second, many of the birds migrate at night, and even prefer cloudy nights. Third, a great authority on bird migration has stated that young and old birds migrate at different times and by different routes. If this is so, landmarks are of no value to the young birds which have never been over the route before.

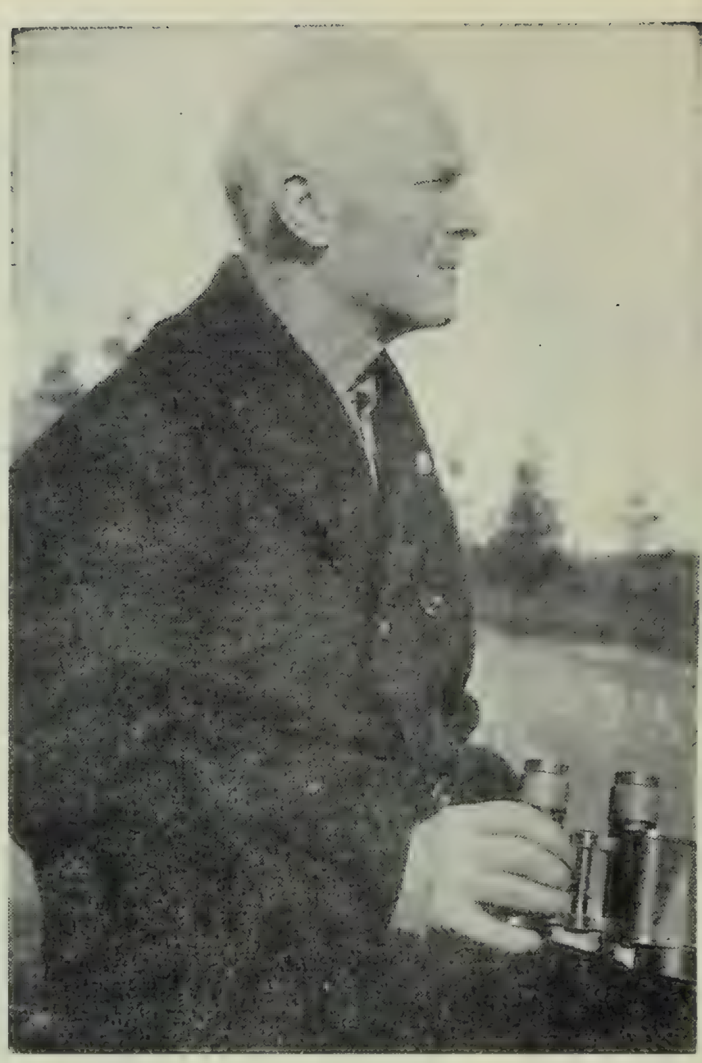
Some scientists believe that birds possess a special sense—*a sense of direction*—as accurate and trustworthy as a compass. This sense guides the vast multitude of migrating birds back and forth across thousands of miles of land and water, year after year.



Main Routes of Migrating Birds

1
2
3
4
1. Pacific Coast Route
2. Great Plains Route
3. Mississippi Route
4. Atlantic Coast Route
xxxx—Winter and Summer homes of the Golden Plover and routes followed when migrating North and South.

Questions and Things To Do



A great Canadian naturalist, Jack Miner, who died in 1944. He was widely known for his work in tagging Canada Geese and other birds to learn about their migration habits and routes. He did very much to interest people in protecting wild life. His home was at Kingsville, Ont. (Photo by courtesy of Jack Miner.)

1. Watch for the fall change in the plumage of male birds. Try to recognize your summer bird friends in their fall and winter dress. Why is the fall plumage of birds dull in color?

2. Watch flocks of birds as they make practice flights. Does each flock seem to have a leader? Certain birds, some of the shore birds in particular, fly in regular formation, all wheeling and turning at exactly the same instant. Watch flocks of shore birds, to see if you can catch the signal, if one is given, that governs their flight movements.

3. Prepare outline maps, and mark on them the summer and winter homes of some of the birds with which you are familiar. Use different signs to mark summer and winter homes, or draw or paste on your map small pictures of the birds whose migration story you are illustrating.

4. Discuss possible reasons why birds migrate. Do scientists know exactly why birds travel north in the spring and south in the fall?

5. How do birds find their way on their long north and south journey?

6. Ask people who have resided a long time in your district if they can remember instances where birds, usually seen only during the summer, remained throughout the winter.

Places of Protection for the Birds

We have known for a long time that most birds are indeed valuable friends and helpers. They assist us in protecting our crops from insects and weeds to a far greater extent than a great many people realize. Of late years more and more attention is being given to the protection of useful birds. *Bird sanctuaries* or places of protection have been established by governments and private persons in a great many parts of the country. All Dominion and Provincial parks are bird sanctuaries. A very widely known private sanctuary is the one established at Kingsville, Ont., by Jack Miner, who for many years was a great bird-lover. In each province several wild life sanctuaries have been established by people interested in preserving wild life.

It is against the law to shoot birds in the sanctuaries or to molest their nests or eggs. The purpose of the sanctuaries is to provide migrating birds with safe feeding grounds and stopping places on their long journeys, and in the case of birds that remain all summer in the vicinity of the sanctuaries to provide safe places in which to build their nests and raise their families.

Almost everyone who is interested in protecting the birds can have a small sanctuary in his own backyard or on his own farm. Trees and vines should be planted to provide nesting sites and food. Hawthorn, choke-cherry, saskatoon, Russian olive, mountain ash, cotoneaster, and Virginia creeper (a vine) are a few varieties. Every precaution should be taken to protect the birds from their natural enemies, especially cats.

Questions and Things To Do

1. Of what value are bird sanctuaries, (*a*) to the birds, (*b*) to man? If there is a bird sanctuary near your home, you should learn all you can about it.

2. Why have bird sanctuaries been established?

3. State the location of several bird sanctuaries.

4. Look in magazines, such as *Canadian Nature*, and others for stories about sanctuaries.

5. How can you establish a bird sanctuary in your own backyard?

The Spring Migration of Birds

As soon as the first mild days of spring suggest that winter is gone, many boys and girls, and older folk too, begin to watch for the return of the birds. It is just like meeting old friends, when you find that the Robins and other birds are back again. Who, in your school, will see the first spring arrivals?

At what time of year do the migrating birds return? Some of them come north very early. Horned Larks arrive in February, often before the snow is gone. They seem to begin "house-keeping" at once. Their nests are built on the ground, and both nest and eggs may be found frequently in the very centre of a snow drift. We wonder how these brave birds manage to keep their eggs warm under such difficult conditions. During March, other hardy birds arrive—Crows, Mallard Ducks, Canada Geese, Meadowlarks, Tree Sparrows, and Juncos. Some of the early birds do not go very far south to spend the winter, and they return to their summer homes during the first mild spring days. Birds such as Juncos, Tree Sparrows, and others, stop with us for a few days only, then go farther north to

their nesting grounds. These birds are known as *transient visitants.* A great many birds return in April and May. Most of the late arrivals remain all summer and are called *summer residents.* By the end of May the great spring migration of birds is usually over. The Warblers, Orioles, Wrens, and many others will have arrived and selected their summer homes. What a busy time of song and nest-building it is! The spring migration of birds is usually very orderly. Long migrations may extend through several months. Unless hindered by winds or storms, most of the birds arrive almost exactly at the same time each year.

APPROXIMATE SPRING ARRIVAL OF SOME COMMON BIRDS

Name of bird	Approximate date of arrival	
Horned Lark	Feb. 10-28	S.R.
Crow	Mar. 10-20	S.R.
Mallard Duck	Mar. 10-31	S.R.
Canada Goose	Mar. 20-31	T.V.
Meadowlark	Mar. 20-31	S.R.
Tree Sparrow	Mar. 20-31	T.V.
Slate-colored Junco	Mar. 20-31	T.V.
Killdeer Plover	April 1-10	S.R.
Flicker	April 1-10	S.R.
Song Sparrow	April 1-10	S.R.
Robin	April 1-10	S.R.
Franklin's Gull*	April 11-20	S.R.
Canvasback Duck	April 11-20	S.R.
Red-winged Blackbird	April 11-20	S.R.
Bronzed Grackle	April 11-20	S.R.
Mourning Dove	April 21-30	S.R.
Chestnut-collared Longspur	April 21-30	S.R.
White-throated Sparrow	April 21-30	T.V.
Myrtle Warbler	April 21-30	T.V.
Loggerhead Shrike	April 21-30	S.R.
Ruddy Duck	April 21-30	S.R.
Marsh Hawk	April 21-30	S.R.
American Coot (Mud Hen)	May 1-10	S.R.
Wilson's Phalarope	May 1-10	S.R.

Name of Bird	Approximate date of arrival	
Western Willet*	May 1-10	S.R.
Spotted Sandpiper	May 1-10	S.R.
Cowbird	May 1-10	S.R.
White-crowned Sparrow	May 1-10	T.V.
Barn Swallow	May 1-10	S.R.
Bank Swallow	May 1-10	S.R.
House Wren	May 1-10	S.R.
Brown Thrasher	May 1-10	S.R.
Black Tern	May 11-24	S.R.
Marbled Godwit*	May 11-24	S.R.
Nighthawk	May 11-24	S.R.
Kingbird	May 11-24	S.R.
Baltimore Oriole	May 11-24	S.R.
American Goldfinch	May 11-24	S.R.
Yellow Warbler	May 11-24	S.R.
Catbird	May 11-24	S.R.
Least Flycatcher	May 11-24	S.R.
Eared Grebe	May 11-24	S.R.
Cedar Waxwing	May 11-24	S.R.
Sharp-tailed Grouse (Prairie Chicken)*		P.R.
Hungarian Partridge*		P.R.
Chickadee		P.R.
House Sparrow		P.R.
Snow Bunting (Snowbird)		W.V.
Bohemian Waxwing		W.V.
Pine Grosbeak		W.V.

NOTE—Summer Residents (S.R.) nest in Southern Canada; Transient Visitants (T.V.) pass through Southern Canada on migration; Winter Visitants (W.V.) are observed in Southern Canada during winter only; and Permanent Residents (P.R.) are found in Southern Canada throughout the year.

* Prairies only.

The birds in the table on page 147 are ones that are common in many parts of Southern Canada, and the arrival dates are fairly accurate for most parts of our country. Of course, there are many other birds in your locality that are not in this table. Use the table in watching for the arrival of the birds listed, and learn what you can about the arrival dates of other common birds.

Dangers of Migration

The birds must brave many dangers on their long north and south journeys. Some observers state that many of the smaller land birds travel at night, and most water-fowl and shore birds migrate by day; others suggest that both large and small birds may travel either by night or by day, depending on which is more convenient. Stops must be made for feeding and resting. Then animal enemies on the ground are a source of danger. Sudden changes in the weather, such as cold spells, snow, and wind storms, cause great hardship among the migrating birds. They are often driven far off their course, even out to sea, and have difficulty in finding food during severe storms. Frequently very many die as a result. Numerous birds lose their lives

Do you know these early spring arrivals? Watch for them.

each year when they fly headlong into such obstacles as lighthouses, high bridges, and telephone wires.

Does it not seem to be worth while to do what we can to help the birds by establishing bird sanctuaries, setting out food, holding their natural enemies in check, and doing other things which afford them assistance and protection?

Questions and Things To Do

1. Name six birds that we expect to return very early each spring. On what date this year did you see your first one in each case?

2. Find, by referring to the chart on page 147, what month or months offer the best opportunities for studying bird migration. By what time in the spring is migration usually over?

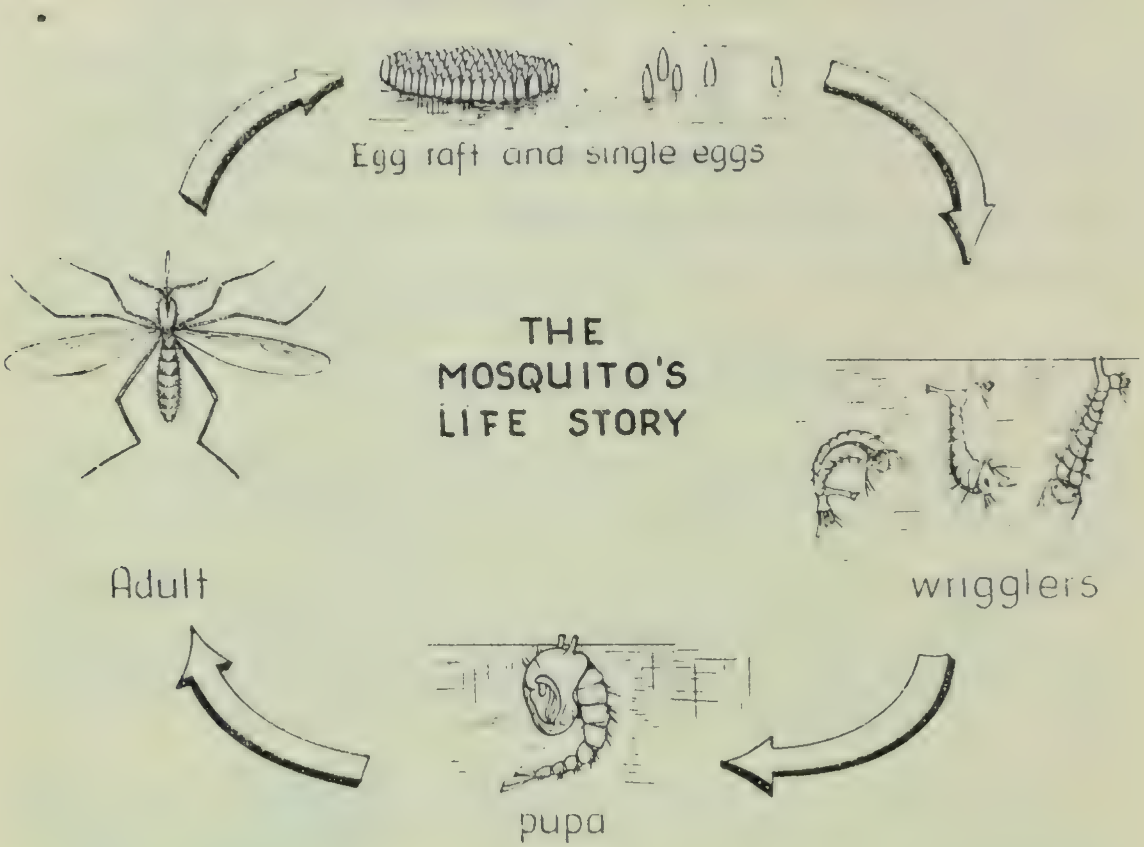
3. Name two birds among the transient visitants which may be seen in the spring and fall. Why are they called transient visitants?

4. Many people who are interested in birds have identified more than 100 different kinds in one year. How many can you recognize? Keep a record of your spring observations as follows:

MY BIRD RECORD FOR (State year)

Bird	When Observed	Where Observed	Alone or in flock	Other Facts Observed

A MOSQUITO HATCHERY



Have you ever seen mosquito wrigglers in stagnant water in a pond or rain barrel? They can be found in most stagnant pools in warm weather. If you find a few, keep them in a gallon jar of the water in which they were found. Take the jar to school and cover the top with a piece of cloth held in place with an elastic band. Stand the jar near a bright window. If you look at the wrigglers each day for several weeks you may see the mosquito's complete life story. Compare the stages with the drawing on this page.

Place a few wrigglers in a jar of water and see what happens after you pour a drop of oil on the surface. Pouring oil on stagnant pools is one way of controlling mosquitoes. DDT sprays also kill them. Thousands of these pests are eaten by fish, birds, frogs, toads, and dragonflies. Why should we protect these animals?

ARBOR DAY

Every school should give particular attention to *Arbor Day.* Special activities should be planned and undertaken. Why? Because Arbor Day offers us an opportunity to make a contribution to our school and community that will endure long after we have finished our studies and graduated. *The chief activity of Arbor Day should be the planting of one or more trees.* Luther Burbank, who produced more new kinds of plants than any other man, once said, "The greatest thing in the world is to make others happy." Planting trees around your school not only improves the appearance of your school and adds to your own happiness and enjoyment, but it is a real contribution to your entire community and will add greatly to the pleasure of all the people who live near your school. Let us plan this year to make Arbor Day a real event.

What shall we include in our programme for Arbor Day? The following are some suggestions:

1. Plans should be made well in advance. (*a*) Soil must be well prepared for the trees that are to be planted, (*b*) trees must be ordered, or native trees in near-by woods or bluffs selected and marked, (*c*) talks should be prepared, (*d*) suitable decorations (paper cut-outs, etc.) may be placed in the school-room.

2. Above all *prepare to plant trees on Arbor Day.* Plant trees to honor the memory of outstanding citizens of the community—the first teacher of the school, a well-known pioneer, or some other person. Give each tree the name of the person in whose honor it was planted.

3. Prepare talks about trees. Some topics that might be discussed are:

- (*a*) *The Value of Trees.*
- (*b*) *Kinds of Trees.*
- (*c*) *The Value of Our Forests.*
- (*d*) *Evergreen Trees.*
- (*e*) *The Enemies of Trees.*
- (*f*) *Care of Windbreaks.*
- (*g*) *Growing Trees from Seed.*
- (*h*) *The Planting of Trees.*
- (*i*) *How Your Community Protects Valuable Trees.*
- (*j*) An *autobiography* is the story of the life of a person told by the person himself. A good subject for an Arbor Day talk would be the *Autobiography of a Tree.* Select the tree that is familiar to you.

4. Memorize poems about trees.

5. Learn songs about trees.

6. Show pictures and slides of trees.

7. *Science Activities* (revised edition), Books 1 and 2 (W. J. Gage & Co.), also have useful information in simple form about planting trees.

8. If the windbreak around your school is not in good growing condition plan to begin on Arbor Day the work necessary to recondition it.

NOTE: Trees for shelter belts on farms and at schools in the Prairie Provinces are supplied free by the Forestry Nursery Stations at Sutherland and Indian Head. Enquiries about such trees should be forwarded by *the teacher* or *a school trustee* to The Superintendent, Forestry Nursery Station, INDIAN HEAD, Saskatchewan. Applications for trees must be made by trustees.

In Ontario, trees for school windbreaks may be obtained free by applying to the Department of Lands and Forests, Parliament Buildings, Toronto. Requests for trees should be made during the fall or winter for delivery in the spring.

The two girls are watching some butterflies and small bees gathering nectar from the flowers. The boys are studying some flowers to learn their characteristics. In every garden there are many interesting things to watch and study.

LET US PLAN AND PLANT A GARDEN

Last summer Betty and Tom had a garden. It was a delightful one. There were always a few plants in flower because they had planned it to give them a succession of blooms all summer. Usually several colorful butterflies were to be seen stepping daintily across the faces of the larger flowers and thrusting their long tongues deep into the flower to sip nectar. Big yellow and black bumble bees probed into other blossoms, and became covered with pollen as they, too, searched for stores of nectar. Tom and Betty gathered many bouquets for themselves and their friends. Indeed they found that one of the best things about their garden was that not only did they enjoy it very much themselves, but it proved to be a great source of pleasure to others as well.

Varieties and Arrangement

What fun Betty and Tom had planning their garden! After talking it over carefully they decided to grow flowers and not vegetables. They decided, also, that since this was their first attempt at gardening it would be better to start with a garden that was not too large. Then they obtained a seed catalogue and studied the illustrations and descriptions in order to make a good selection of flowering plants for their garden. They were careful to note whether each plant they thought they would like was hardy and easy to grow or not. Betty wrote out a list of six or eight plants they liked best. They selected some for the border and front part of their garden, and others that were taller for the back parts. Tom thought it would look well to have a climbing plant growing up over the fence to form a background.

Then one of the young gardeners suggested that they show their list to Mr. Gordon and ask his advice. Mr. Gordon had a splendid garden the previous summer and Tom and Betty knew that he would be glad to help them. He told them that in planning their garden, they must keep in mind (*a*) the time of flowering, (*b*) the color, (*c*) the height and (*d*) the space required by each full-grown plant. Groups or beds of plants with flowers of the same color are more attractive in appearance than a mixed-up arrangement. Low-growing plants should be placed in front with the taller ones toward the back. A stiff, unnatural arrangement should be avoided.

Finally they decided to have a border of dwarf white sweet alyssum and scarlet flax in alternate rows or groups, the alyssum a little in front of the flax. Behind each group of flax, they planned to have a few calliopsis plants, and behind the alyssum several large-flowered zinnias. Sweet peas, of mixed colors, were selected for the background.

For our own garden, we could well select the varieties which Tom and Betty grew. Or in place of these varieties, *Drummondi phlox*, or *nasturtiums*, will provide colored blooms for a long period during the summer, and *scarlet runner beans*, *wild cucumber*, or *morning glories*, may be substituted for the *sweet peas* in the background. Remember, the varieties we have just listed are only suggestions. The seeds of all can be planted in the open in the garden with good results. The plants bloom during the greater part of the growing season. But there are many other varieties that you may prefer. Let your garden be an expression of your own individuality.

There are varieties that must be started early indoors or in hot-beds during the last two weeks in March or the first two weeks of April. Consult books such as *Science Activities*, Book 2 (W. J. Gage & Co.) or others about the best of these varieties and about methods of starting them. Many people find a great deal of pleasure in starting plants early so as to have early flowers in their garden.

Where Should the Garden be Located?

A sunny location, well protected from strong winds is desirable. Select a place sheltered by the school building or surrounded by a dense hedge or shrubs. Remember, do not for the first year at least attempt too large a garden. A small garden surrounding the base of the flag pole is one suggestion. Your garden may need to be fenced for protection. *A school garden should not be attempted unless it can be (a) fenced, and (b) well cared for during the summer vacation.* When no desirable location seems to be available at school, many boys and girls plant gardens at home. If arrangements cannot be made for either a school or a home garden, let us have a window box to brighten up the appearance of our school.

A garden located in a corner. It is in a sunny but well-protected place.

Drawing a Plan

Tom said he would draw a plan of the garden to scale and mark the location of each variety they had selected. Betty decided to draw a diagram which would illustrate somewhat the appearance of the garden. She put tiny dots of the colors of alyssum, scarlet flax, calliopsis, zinnias, and sweet peas in the arrangement they had planned, This helped them to form a better idea of the appearance of their garden when in bloom. They showed their plans to Mr. Gordon and others in order to make sure that they were arranging their plants to the best advantage. It was while they were drawing the plans, that they decided to plant a couple of red sunflowers at each back corner to stand all summer long like tall watchful sentinels.

Before they were ready to wait for spring in order to plant their garden, Betty and Tom made a list of *Things Required* and *Things to Be Done.* They studied their seed catalogues and questioned Mr. Gordon, then wrote under the heading *Things to Be Done* the date on which their seeds should be planted and other details to be attended to before garden time.

A Good Garden Requires Good Soil

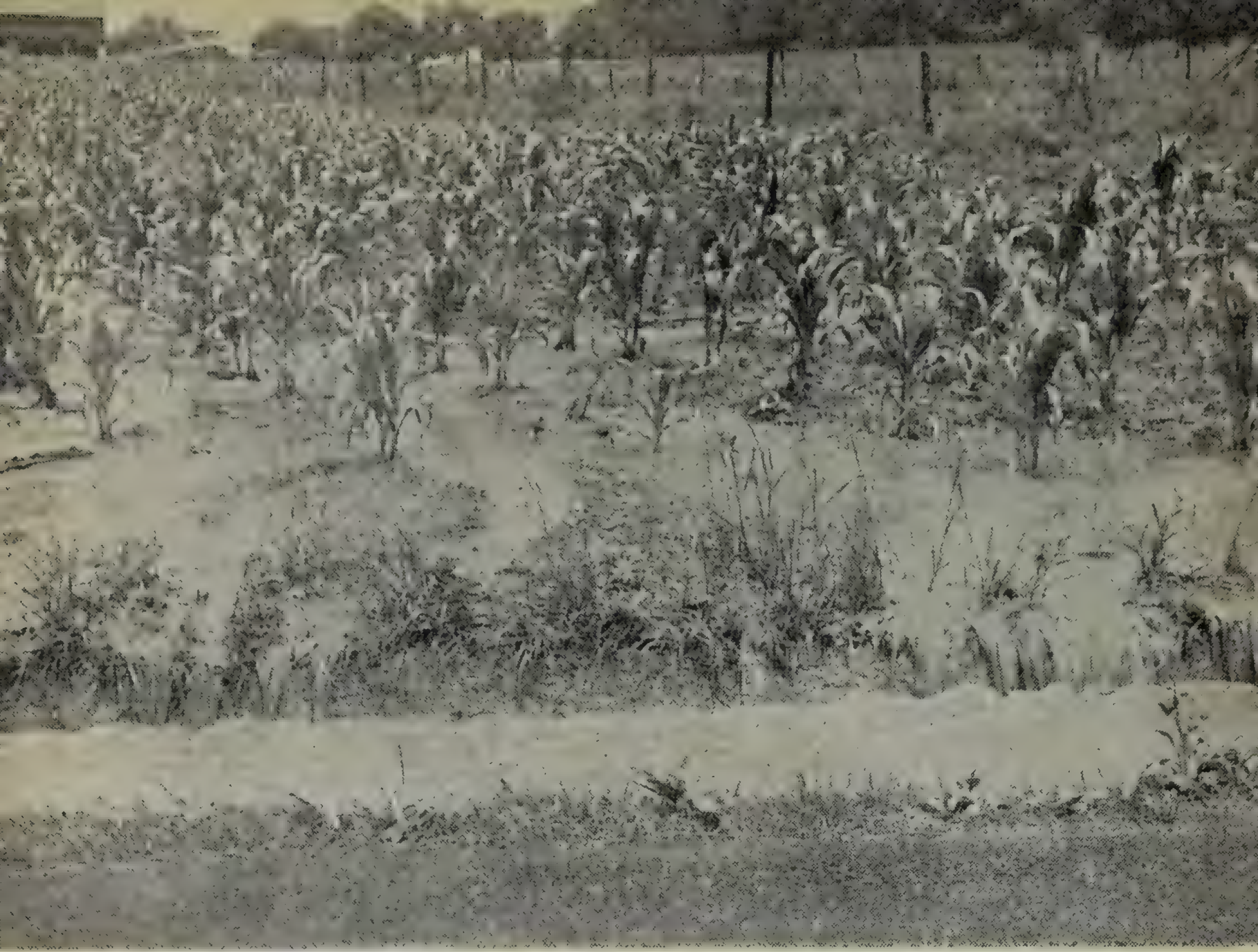
During their searching for information about plants for their garden, Tom and Betty also learned a good deal about soil. They found out, for example, that since the soil in their garden was a sticky clay it would improve it to add a quantity of fine sand. Mr. Gordon suggested that *wood* or *soft coal* ashes could be used in place of sand. They learned, too, that a good supply of well-rotted manure should be added. Every gardener whom they questioned strongly advised them that the soil must be deeply dug and well worked up before it would be in good condition for planting seeds. If sand or ashes and manure are added, they must be thoroughly mixed with the soil. It is necessary to plan carefully to have well prepared, rich soil for a garden. Most of the seeds we shall be planting are quite small. They cannot grow well in lumpy, poorly prepared soil.

Plants find in the soil a large part of the materials they require. What do plants need? For one thing, they require *nitrogen.* Nitrogen is necessary for growth and the deep green color of plants. It is present in the air in the form of a gas, but is also present in the soil in solid substances. Most plants secure the nitrogen they require from the soil. Plants also need *phosphorus, potassium,* and *other substances.* All these substances have special uses in the growth and development of the plants.

Before they are of much use to plants, substances in the soil must be in the form that will dissolve in water.

Rich, dark soils well supplied with the materials required by plants are known as *fertile soils.* The soil in your garden must be fertile before you can grow vegetables or flowers successfully. Fertile soils contain an abundance of *humus* or decayed vegetable and animal material, and are not too sandy to hold sufficient moisture, nor so clayey that they remain water soaked and cold.

A good gardener takes good care of his tools. Be sure to scrape the soil from your spade and other tools before you put them away after using them.



Notice carefully the water running off this field of corn. There has been a heavy rain. What does the muddy appearance of the water show? What is happening to the good surface soil in the field? (U.S. Soil Conservation Service photo.)

A Good Gardener Practises Conservation

It is not possible for you and the other members of your family to eat heartily of the good things on the dinner table and have as much left on the table at the end of the meal as there was at the beginning. Nor is it possible to grow plants in a garden or field without removing some of the "plant food" materials stored there. A good gardener returns at frequent intervals the materials his crops take from the soil.

The word *conservation* is an important one for all of us to know. It means to use (*a*) without wasting, and (*b*) to renew or replace when possible.

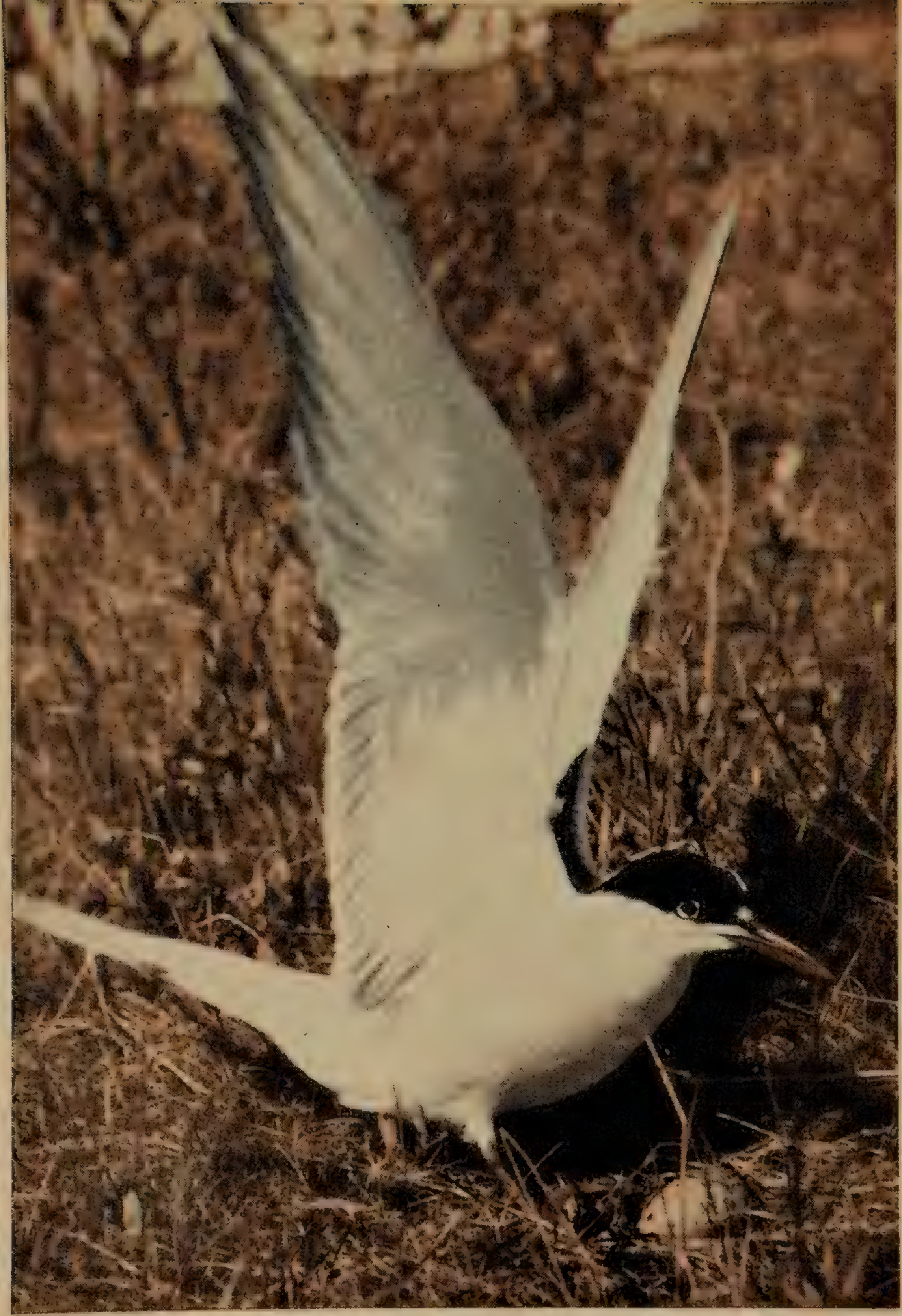
The aim in gardening, or in growing field crops, should be to use the soil and at the same time keep it in good condition to grow more crops. We must return to the soil the plant food materials which plants remove while growing. This can be done by using barnyard manure and other fertilizers. A good supply of humus must be maintained in the soil.

Not only must the fertility of the soil (supply of plant food materials) be conserved, but the soil must be protected from damage by strong winds and running water. Even a heavy rain can cause serious damage by washing away much good soil. To prevent water and wind damage, a good supply of plant material must be maintained in the soil to keep it in place.

Planting Our Garden

Planting day is a busy, happy day! But let us be sure before we plant a single seed, that we know exactly where we are going to plant each variety. In other words, we must have a definite plan. Do you remember the rules for good arrangement? (See page 154.)

Many people make the mistake of planting seeds too deeply. The smaller the seeds, the nearer the surface they must be planted. Prepare shallow rows—for many varieties a trench one-quarter inch in depth is sufficiently deep. Do not sow too thickly—sowing seeds too thickly is a waste and makes thinning more difficult. After seeds are sown, cover *lightly* with *finely pulverized* soil. It is a good plan to press the soil down around the seeds with the back of the hoe or rake. Some people like to pour water in the seed trench just before they sow the seed. If you do this, do not pack the soil too hard after the seed is covered. Avoid



The Arctic Tern is the world's champion long-distance traveller. It nests in the Far North and winters near the South Pole, making a yearly round trip of 22,000 miles. It closely resembles the common Tern, commonly seen over bodies of water on the prairies. Both have a distinct black cap and long, forked tail. The bill of the Common Tern is black tipped. The Arctic Tern has a red bill. (Photo by courtesy of W. H. Carrick.)

Electricity

1. static electricity - lightning,
rubbing a pen on wool,
combing your hair, rubbi
your feet on the floor,
2. Battery - flashlight, car,
telephone.
3. Current - lights

Hoes and rakes are being put to good use by these pupils to destroy the weeds and keep the soil in their garden in good condition.

tramping on the garden more than absolutely necessary while working it.

Plants Need Care and Help All Summer

If your garden is to grow well, it must have careful and correct care during all the growing season.

Watering: If water is available, moisten the garden soil well each evening. Be very careful, at first especially, to avoid washing the seeds out of the soil or damaging tender young plants. Water your garden with a fine gentle spray. You must do more than merely sprinkle the surface of the soil. To be of value, enough water must be supplied to moisten the soil to some depth.

Thinning: After the young plants have pushed up one by one above the ground, one of the first things you must do is to thin them. Shortly after the second pair of leaves appear, thin your plants to about one inch apart in the rows. Then thin later to the proper distance. Remember that some full-grown plants require two feet or more of space.

Weeds: Be sure to keep your garden free from weeds. Not only are many weeds unsightly, but they rob your soil of moisture and "plant food" and crowd out the less hardy garden plants. A good gardener will not have a weed in his garden.

Cultivation: Keep the soil around your plants well hoed during the summer. If you do, it will not dry out as quickly, and the weeds will have less chance to grow. The surface soil should be fine and loose at all times. Sometimes you can almost see the plants growing after giving the soil a good cultivation—try it! It is a good plan to cultivate the soil thoroughly after each rain.

Other Care: Remove dead leaves and withered blooms at frequent intervals. Provide supports (stakes of suitable length painted green) for weak-stemmed plants.

Keep all things about your garden "spick and span"—it will add to your enjoyment if you do.

Problems and Things To Do

1. Of course the best way to review what you have learned about a garden is to plant one and care for it during the summer.

Note what is said on page 156 about a school garden.

Study seed catalogues and ask an experienced gardener to help you plan a garden of your own. Many plants must be started indoors and transplanted outside later. Perhaps you would like to try growing some of these. If so, include one or two kinds in your plan. Remember, it is better not to try to plan or to grow too large a garden at first.

2. Make a list of the things Betty and Tom did in planning their garden. Be prepared to explain the value of each of the things you mention in your answer.

3. Plan a flower *or* a vegetable garden *or* a combination flower and vegetable garden. *When you have sufficient information,* draw a plan of your garden (a) similar to Tom's plan, or (b) a colored diagram similar to the plan drawn by Betty.

4. Be ready to tell about the following:
   - (*a*) the best location for a garden.
   - (b) how flowers in a garden should be arranged.
   - (c) how sticky clay soils can be made less sticky.
   - (d) how to practise conservation in a garden.
   - (*e*) two reasons why a good supply of well-rotted manure should be dug into garden soil frequently.
   - (*f*) why garden soil should be well prepared.
   - (g) the care gardens require during the summer.

5. What other problems might arise in connection with planning and planting a garden? Make a list of these problems and be ready to tell about them.

A Window Box for the School

The pupils of Western School planned to prepare several window boxes. They organized committees to undertake the various parts of the necessary work. Later one of the pupils wrote the following story:

"George and Howard agreed to make the box. They measured the width of the window sills on which it was planned to place boxes. The boxes were about 7 inches deep and 8 inches wide. Thick, strong boards were used, and wire or metal strips were placed on the corners to strengthen the boxes at these points. The boys bored holes in the bottom of the boxes to provide drainage.

"The brackets to support the boxes were constructed by Tom and Bill. They made sure that the brackets were secure and strong.

"Following a meeting of all the pupils to decide upon colors, Mary and Gertrude painted the boxes and the brackets.

This beautiful window box contains big, yellow, *double nasturtiums* and *creeping Charlie.*

"What a time we had deciding upon what to plant in our boxes. Kathleen and Hazel asked several people who have been very successful with window boxes. Finally, we decided to make each box different. In one, we would plant *petunias* and *trailing nasturtiums* and in another *geraniums* and *creeping Charlie.* We thought that another year after we had more experience we might try plants, such as *lobelia*, *alyssum*, *German ivy*, and others. In planting window boxes, put the taller growing plants to the back and centre.

"When the boxes were ready for soil Jack and Roy went to work. They placed a layer of gravel in the bottom for drainage. Then they filled the box with well-enriched soil to within one-inch of the top.

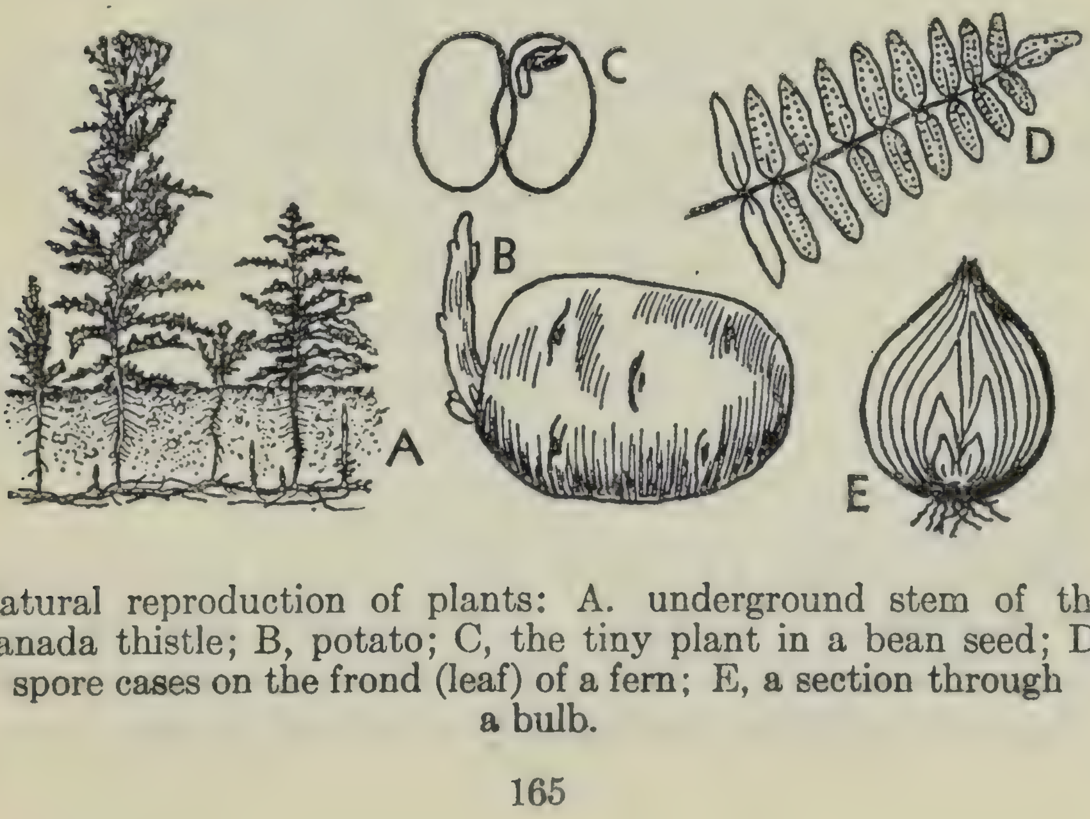
"We all watched while Grace and Elsie planted the young plants in the boxes. At first, we placed the boxes outdoors when it was warm and took them indoors at night in case of frost. Later, our boxes were left on their brackets all the time. As window boxes dry out quickly, committees were formed to water them each day. When the holidays came, two pupils took the boxes home to care for them until school opened in the fall."

SOME WAYS OF PLANTS

George and Bob usually walked to and from school together. Often they stopped to look carefully at plants along the way. They had learned that when two boys keep their eyes open, there are many interesting things to see.

How New Plants Get Started

The struggle for life among plants is so keen that many plants do not depend upon seeds alone to reproduce themselves. A large number have developed several other ways. Man, too, has invented methods of starting new plants. Some of these methods are quicker than seeds. Others produce new plants that are more suited to our purposes than those grown from seeds.



Natural reproduction of plants: A. underground stem of the Canada thistle; B, potato; C, the tiny plant in a bean seed; D, spore cases on the frond (leaf) of a fern; E, a section through a bulb.

Nature's Methods of Reproducing Plants

Seeds are Nature's most common means of reproducing flowering plants. A seed is really a "baby" plant with a supply of food. As long as the seed remains dry, the tiny plant lies asleep. In the moist, warm soil, however, the plant in the seed wakens and pushes its leaves up to the sunshine and the air. Many seeds are carried long distances from the plants which produce them. Some have parachutes or wings to sail through the air. Others are carried by rivers and streams. Many steal rides on animals. By various means they venture forth to seek new homes. A very great many plants produce seeds. Name as many as you can.

Some plants send out along the surface of the ground trailing branches or *runners.* The runners are jointed and when the joints touch moist soil they take root. Thus a new plant is produced. The strawberry is an example of a plant that spreads in this way.

Many plants are reproduced by *underground stems* or *rootstocks* that push out through the soil. New plants develop at intervals along the rootstock. Many grasses, including the troublesome weed couch or quack grass, thistles, and other plants are spread by this means. The potato is a swollen underground stem called a *tuber.*

Red raspberries, blackberries, roses, lilacs, and other plants send up sprouts or *suckers* from the roots. New plants are often produced so rapidly in this way that they become a nuisance to the gardener.

Onions, tulips, and other plants of the same family are reproduced by *bulbs.* We learned last fall by cutting an onion in two that it consisted of a short stem, roots, two buds, and many layers of thick, fleshy leaves packed with food. Sometimes small bulbs, called "daughter" bulbs, develop around a large bulb. The "daughter" bulbs will grow into new plants.

The stately and beautiful gladioli and a number of other plants are reproduced by *corms.* Corms resemble bulbs in appearance, but are solid throughout. Small corms are developed in very much the same manner as "daughter" bulbs.

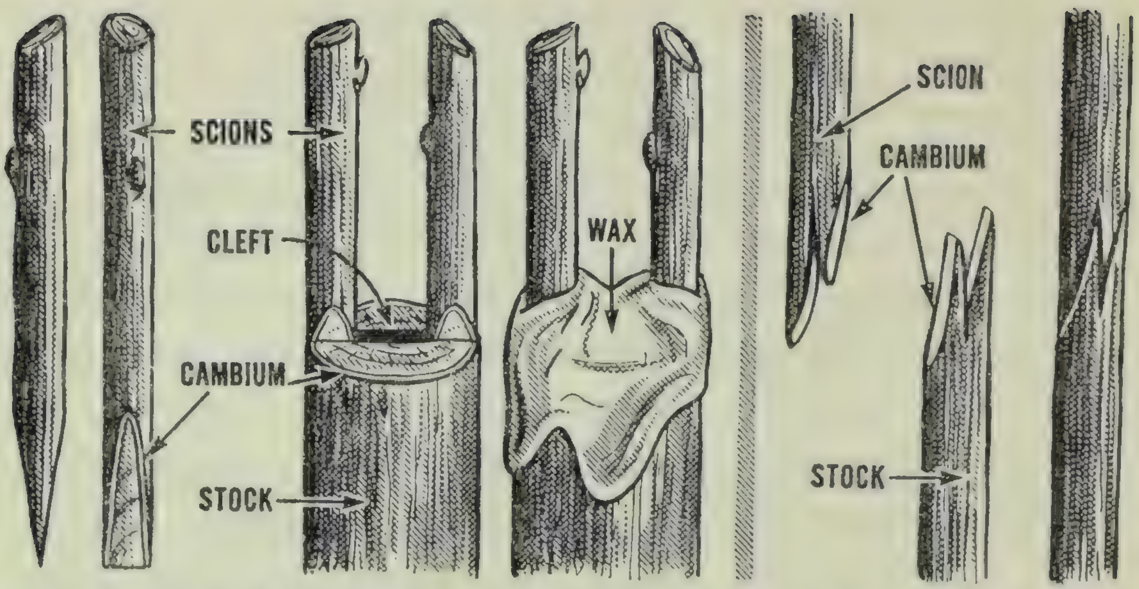
Flowerless plants, such as mushrooms, molds, ferns, and others are reproduced by *spores.* You have learned more about spores during your study of bread mold. Remember spores are not seeds, but when they fall into warm, moist soil or other favorable growing place they produce new plants. If you examine the underside of the frond (leaf) of a fern, rows or dark brown dots are often to be found. These are the spore cases of the fern. Each contains many spores.

Cutting, Grafting, Budding

Sometimes man finds that growing new plants from seeds is too slow or too difficult, or is unsatisfactory for other reasons, so he makes use of other methods. Some of these methods are *cuttings, grafting,* and *budding.*

We are all familiar with the method of producing new plants by means of *cuttings* or *slips.* What is a cutting? It is just what the word *cutting* suggests: a piece cut from the leaf, branch, or root of a growing plant, and planted to produce a new plant of the same kind.

In the spring rhubarb roots may be dug up, cut into pieces, including a part of the crown with buds, and replanted. Each piece then grows into a new

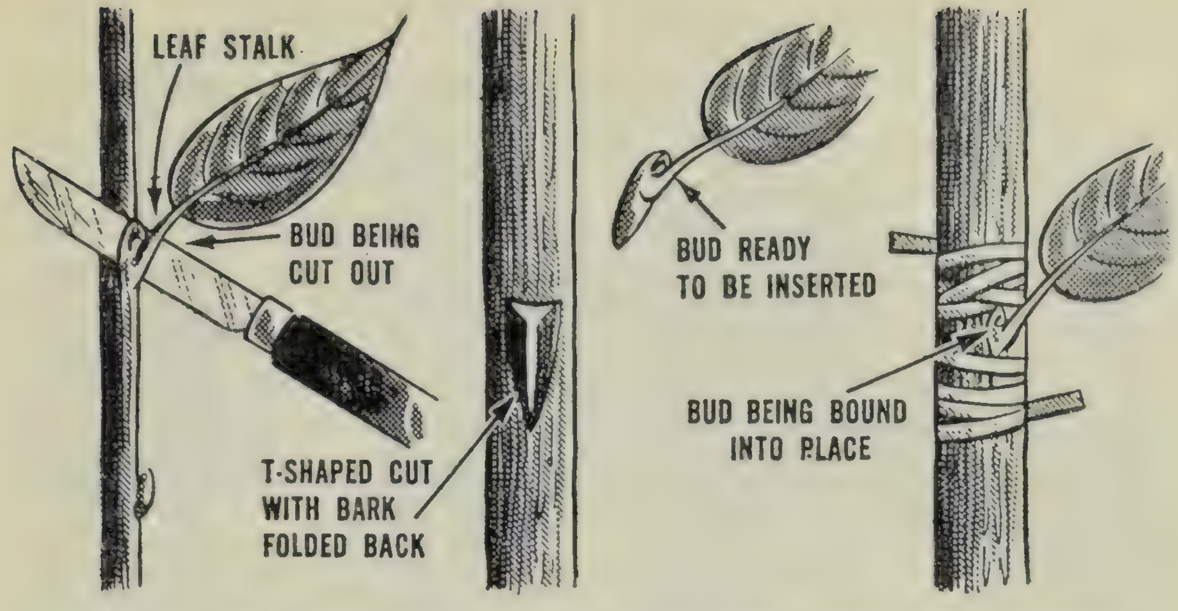


Two methods of grafting branches of one tree or bush on another.

rhubarb plant. This is an example of a *root-cutting.*

Poplars, willows, caraganas, and other plants may be reproduced by *stem cuttings*, eight or ten inches long. Many house-plants, such as geraniums, fuchsias, patience plants, and others may be reproduced by stem cuttings; in fact they usually are propagated by this method.

Do you know that it is possible to make a branch from one tree grow on another related tree? This process is called *grafting.* A study of the illustrations on this page will show you briefly how the two branches to be joined together are prepared. When a *scion* (branch grafted on) is grafted to a stock (part on which scion is grafted), the scion uses the food supplied to it by the stock and soon the two grow together. Great care must be taken to get the growing parts or *cambium* of the stock and of the scion in contact with each other. The scion always retains the characteristics of the tree from which it was taken. Grafting is done to hasten the production of fruit on young trees or to


LEAF STALK
BUD BEING CUT OUT
T-SHAPED CUT WITH BARK FOLDED BACK
BUD READY TO BE INSERTED
BUD BEING BOUND INTO PLACE

Method of transplanting a bud from one branch to another.

improve the quality of the fruit. For example, if you were to plant a seed from a big delicious red apple, then wait for several years while the new tree grew old enough to produce apples, you might be very much disappointed. The apples on your new tree would very likely be small, green, and sour. "How are our fine apples produced?" you ask. The method that must be followed is to plant a seed. Then when the young tree is old enough, graft on it branches (scions) from an old tree that is known to produce good apples. New varieties are not produced by grafting.

Budding consists of inserting a bud from a tree or bush with desirable characteristics into an opening made in the bark of another tree or bush. If properly set in, the bud will grow and produce a new branch. Budding is practised for the same purpose as grafting.

Fruit trees, rose bushes, and even some of the shade trees are among the plants upon which grafting and budding are commonly carried on.

Questions and Things To Do

1. Let us not be content to read about the reproduction of plants. Let us make a study of it for ourselves. *Perhaps we can work together and help each other!* How? Have you a fern at home with spore cases on the fronds (leaves)? If so, could you not take a frond to school to show your fellow pupils? Are there strawberries in your garden? Then why not take a good specimen or two of a runner to school? Cut an onion in two, and look at buds, stem, leaves, and roots. Let us organize an excursion and look for a good specimen of the underground stem of a thistle, or the sucker from a poplar tree.

2. What plants are reproduced by *runners*, by *suckers*, by *rootstocks*, by *bulbs*, by *corms?* Describe each method.

3. Explain how flowerless plants reproduce. Give examples of non-flowering plants.

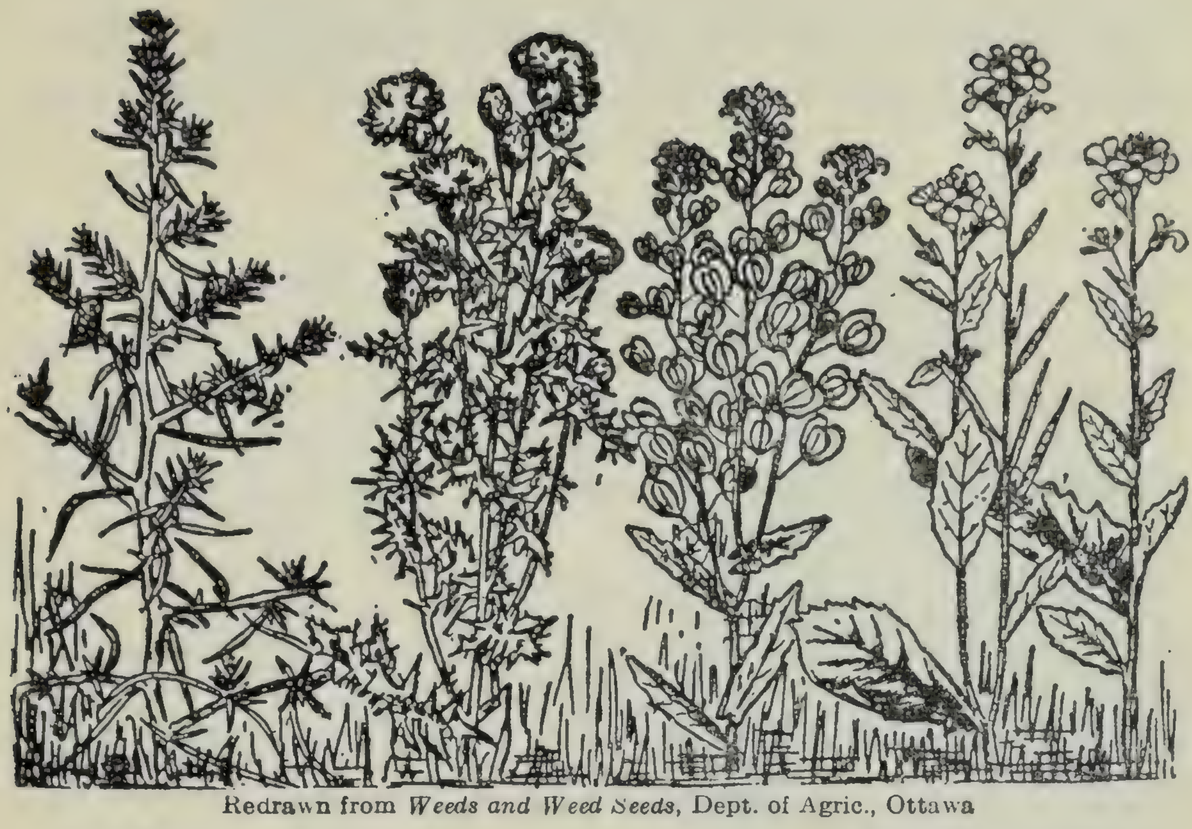
4. How are cuttings made? What are some plants propagated (reproduced) by this method?

5. On what plants are grafting and budding practised? Why are these plants propagated by these methods? Explain the procedure in each case.

How Do Weeds Succeed So Well?

A weed patch and a good garden cannot grow in the same place at the same time. Weeds are harmful. They crowd out weaker but useful plants. They rob the soil of moisture and "plant food". They reduce the value of our crops. Nevertheless we must admit they are very successful plants. They usually thrive in spite of the unfavorable conditions under which they are often obliged to grow. Why are weeds so successful? Let us study a few to find out.

One reason weeds are weeds is their ability to succeed under many and often unfavorable conditions.



Redrawn from *Weeds and Weed Seeds*, Dept. of Agric., Ottawa

They are able to *grow tall* or *short* as the situation in which they are growing requires. They have *many leaves* or *few leaves* depending upon the abundance or lack of water. *They produce thousands and thousands of seeds* and many are reproduced by *underground stems* or *rootstocks* as well. Most of them have *special devices to scatter their seeds* — tufted seeds to sail in the wind, hooked seeds to cling to animals, and tumbling plants which roll for many miles. And if their *seeds* fall into dry soil, they *can remain alive for years* if necessary until favorable growing conditions occur. In dry weather, too, *the roots of most weeds go deep into the soil* in search of water.

With so many useful devices to help them and with their remarkable ability to change their habits of growth, it is not surprising that weeds succeed so well. It requires the utmost watchfulness on the part of the farmer and gardener to keep them out of field and garden.

Problems and Things To Do

1. Obtain a large ripened tumbling mustard plant. With the help of your classmates, count the number of seeds in a section of the plant. Then estimate the number of seeds produced by the whole plant. Do not be surprised if your estimate is almost 1,000,000.

2. Examine a dandelion plant growing in the lawn. Why does mowing the lawn not kill it? How does the flat arrangement of the leaves help it to survive. Dig out a dandelion root. Food is stored in the large tap root so that the plant may get an early spring start. Now do you understand why dandelions bloom so early in the spring?

3. Look for plaintains in your lawn. How is their manner of growing similar to that of the dandelion? How are their roots different?

4. Look for specimens of dandelions, Russian thistles, and other weeds which show differences in leafiness, height, or in other respect due to differences in their surroundings.

5. Make a list of all the reasons that you can think of why weeds succeed.

6. By a series of drawings, or better still a series of pressed and mounted specimens, illustrate the story of the success of several common hardy weeds.

7. Why does the ability to change its habits of growth help a weed to withstand unfavorable conditions?

TO SAVE IS BETTER THAN TO WASTE

Conservation

Jack and Bill each made a strong sling-shot. Now they were in the woods taking shots at the birds and other animals which they saw. Most of the boys' shots missed their marks. But suddenly, a stone which Bill had shot struck a little brown bird. A few feathers fluttered to the ground and the bird disappeared. Both boys laughed at the "success" of the shot.

Why does a good sportsman obey signs such as this one?

But suppose we follow the story further. The little bird fell to the ground, its wing broken. It hid under a small bush, suffering greatly. Unless its wing healed it would die. High up in the tree, a nest full of baby birds waited for their mother to bring them food. But she could not reach them now, for her wing was broken. Further, many of the harmful insects that the mother bird would have caught to feed her family now lived to destroy plants in the garden or in the woods. What a great deal of suffering and harm the careless use of a sling-shot caused!

The important thing to understand and remember about our "sling-shot" story is this: Birds are tremendously valuable. They destroy vast quantities of weed seeds and harmful insects every year. In fact, it has been said that man could not control harmful insects even as well as he does without the help of the birds.

How necessary it is for all of us to practise *conservation* in connection with the birds that live around our homes and in the fields and woods.

The pupils of Western School thoughtfully discussed the conservation of bird life. Ann said, "It means to protect and help the birds." At once John replied, "That is too indefinite. Conservation means that we must provide the right conditions—ponds for ducks and other swimmers, trees for the small song birds, fields for birds that live in the open—so they can find food and raise big families of young birds to take the place of the old birds when they die." What do *you* think conservation means?

Disappearing Animals

Have you ever thought it possible that certain kinds of animals might disappear entirely from the face of the earth? Not only is this a possibility, but it has actually happened.

A beautiful bird called the Passenger Pigeon was once very common in parts of Canada and the United States. Great flocks of these birds darkened the sky. Branches of trees were broken by the weight of the many birds which roosted among them. But the Passenger Pigeon was good to eat and countless numbers of them were shot, clubbed to death, and killed in other ways. The great flocks became smaller and smaller. By 1922 not one Passenger Pigeon remained alive—the only specimens to be seen were dead ones in museums.

Other splendid birds, the Great Auks, lived on islands in the sea. They were killed by tens of thousands for the sake of the oil obtained from them. The last living Great Auk was seen in 1852. These birds, as well as others, have disappeared because of the greed and cruelty of the men who hunted them for gain.

Many people throughout Canada and United States are watching with interest to see what happens to the Whooping Crane, our largest bird. Formerly they were very numerous. However, now (1957) there are only about thirty known to be alive. Are these beautiful birds also doomed to disappear?

The story of the vast herds of buffalo, or bison as they should be called, is another one of wasteful slaughter. Thousands upon thousands of these magnificent animals were killed merely for their skins and sometimes even for their tongues alone. Gradually, of the millions of buffalo that roamed the trackless prairies, only a few scattered herds remained. Today, most of the buffalo alive are living in the national

Why do many wild animals, such as this Rocky Mountain Sheep, need protection to prevent their extinction?

parks of Canada under the protection of the Government.

Animals, such as this splendid Elk, live in the forests. If the forests are destroyed by fire or cut down for lumber, what will happen to their homes and feeding grounds?

Man Upsets the Balance of Nature

If you look sharply, when walking in the woods, you will observe birds, squirrels, and possibly other animals among the trees; butterflies will be visiting the various flowers, and deer and rabbits may peek at you through the bushes. If a stream runs near by, you may find beavers or muskrats, and perhaps fish. Out on ponds and marshes will be ducks, grebes, and other waterfowl.

Many animals live in the woods, on the prairies, and in the ponds and streams because these places furnish them with food, homes in which to raise their families, and protection from their enemies.

Usually Nature brings about a balance in the wild life of an area. For example, if deer become too numerous there will not be enough plants to provide them all with food. If the animals that feed upon the deer increase too rapidly, some of them will not have food. When undisturbed, the wild plants and animals in an

Water helps in several ways to add beauty to the earth. One important way is providing food for plants. Most plants need a great amount of water.

Beauty spots, such as this one, are interesting places to visit often.

(H. M. Halliday photo.)

area tend to become balanced. There will be just enough plants of various kinds and just enough animals so that all can find food and thrive.

Man has been one of the chief disturbers of the *balance of nature*. Sometimes, he has done so thoughtlessly and foolishly. For instance, there have been times when most of the hawks and owls in an area were destroyed. The result was that mice and gophers increased and caused a great amount of damage. When men build a city, plough the land to grow crops, cut down the trees in the woods, and drain swamps and marshes, what happens to the homes and feeding grounds of the deer, the song birds, the ducks, the muskrats, and other animals? In the past, men have hunted and killed many, many animals, some merely for the pleasure of killing, others to sell the meat and hides for profit. Can you not see how the activities of man interfere with the natural lives of many wild animals?

It is not always possible to avoid destroying animals' homes, when new country is being opened up for farming or a city grows and grows out over new areas. But, more and more, man is giving consideration to the possibility of leaving spots here and there in which wild animals can live and wild flowers and trees can grow and delight us with their beauty. To prevent their extinction, it is necessary to protect by law many animals, such as the beaver, deer, ducks, and others.

How Can We Conserve Our Useful Wild Life?

Is it not very evident to you that unless we do something about it, many very useful wild animals will disappear? Unless steps are taken to prevent it, many

Beauty spots such as this should be preserved. (Photo by Dan McCowan.)

of our beauty spots in the woods and on the prairies will cease to be! How much less interesting and beautiful the world would be if there were no colorful wild flowers, no towering trees, no flashing, singing birds, and no wild animals! What can *you and I* do to help save our wild life?

1. We can each say, "I can't leave it to the other fellow. I've got to do something myself!" We can make our home grounds, our farms, our school yards *sanctuaries* where wild animals, wild flowers, and trees will be safe from harm. We can avoid causing harm to plants and animals wherever we are.

2. We can know and observe the *game laws.* These laws set forth that:

(*a*) Some animals cannot be killed.

(*b*) Others, such as moose, deer, ducks, and prairie chicken, can be killed only during certain times of the year.

(*c*) During the hunting or "open" season each hunter is allowed to shoot only a certain number of animals.

(*d*) People who like to hunt and, in places, to fish, must secure a license from the Government.

Be a good sportsman. Do not break the game laws. Tell others about them.

3. We can enjoy wild animals in our *National and Provincial Parks,* and "shoot" them only with a camera. Each of us must be sure to do his share to preserve these parks for all time.

4. We should not pick wild flowers that are becoming scarce. When picking other wild flowers we should leave the leaves and roots. Why? Why should some of the flowers be left to produce seeds?

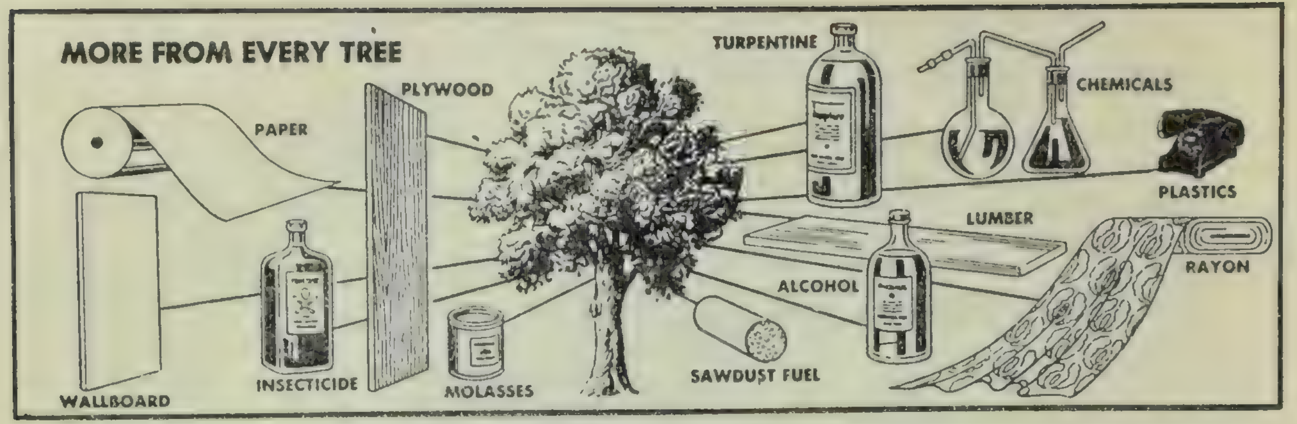
5. When picnicking or camping in the woods we should be very sure:

(*a*) to enjoy but not destroy wild flowers.
(*b*) to leave trees undamaged.
(*c*) to avoid causing damaging fires.
(*d*) to leave camp sites clean and tidy—not littered with tin cans and garbage.

Trees Are Useful in Hundreds of Ways

From wood are manufactured paper, cellophane, rayon, matches, furniture, fertilizer, turpentine, telephone parts, and hundreds of other useful articles and materials. These wood products are worth many millions of dollars each year. The cutting of the trees and the manufacturing process provide work for thousands of people.

John was especially interested in forests and forest conservation. "Our trees are valuable for another very important reason," he told his class mates. "On mountain sides and in other places, forests help to store up water from rains and melting



All these products, and many more, come from trees. Some products, such as rayon, cellophane, plastics, and paper, cannot even be recognized as wood. But all come from trees. In addition, trees add beauty to our surroundings and provide homes for many birds and other animals. Protect the trees. (American Forest Products, Inc., photo.)

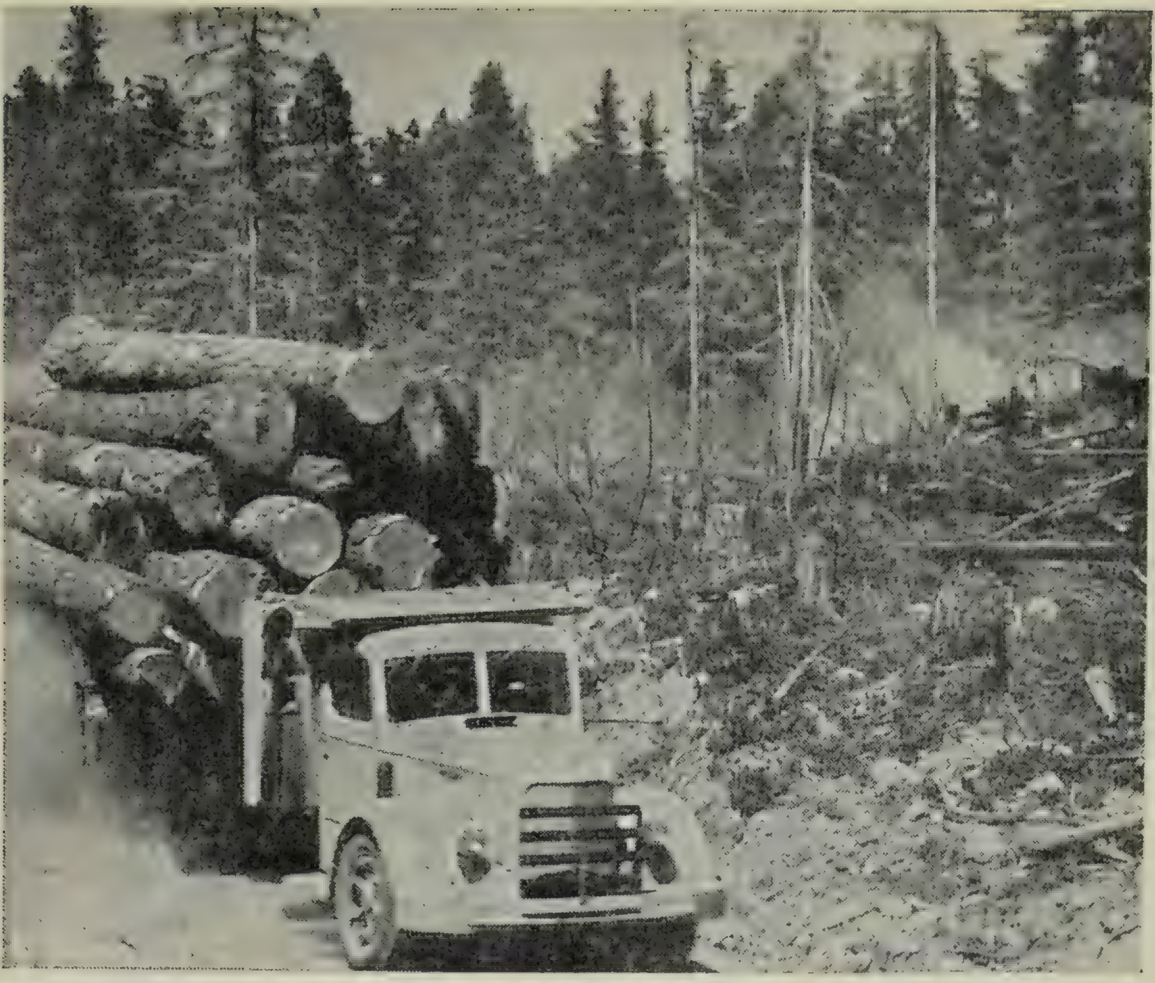
snow and glaciers. Instead of rushing out all at once, the water runs away gradually." Jane was able to add, "The result is floods are prevented and streams that have their beginning in these areas continue flowing throughout the summer."

John continued, "In some parts of the world where the trees have been destroyed the land has become a desert." This is indeed true. The roots of trees help to anchor the soil and prevent it from being washed or blown away.

"I am very glad that we have had this very interesting talk about trees," said Miss Hughes. "It does not take a person, who thinks about it at all, long to understand that our forests are very valuable and important. They must be protected from damage and waste. What can we in Western School do?"

Forest Conservation

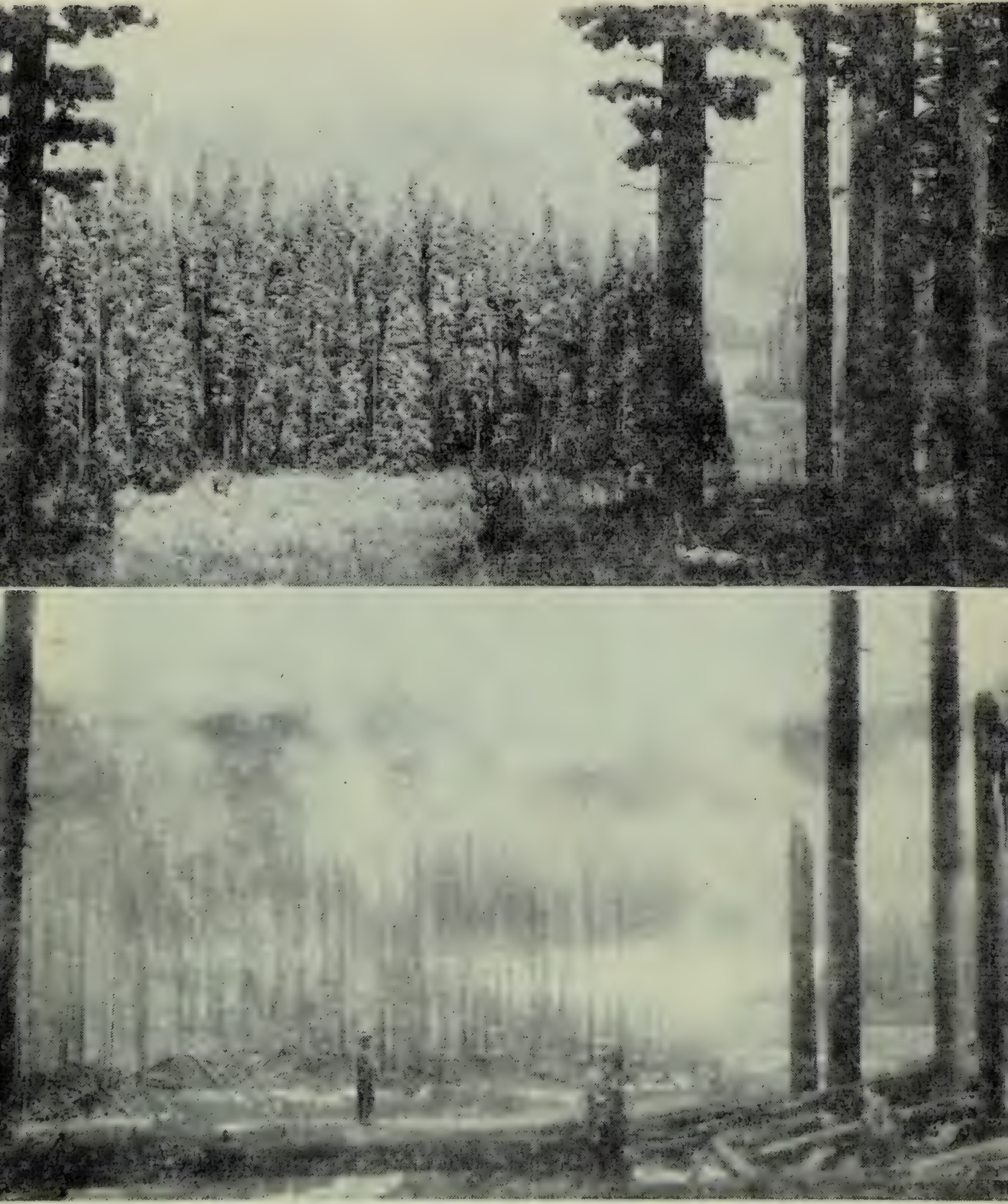
Three enemies endangering our forests are fire, insects, and wasteful lumbering methods.



Unless lumbering operations are carried on carefully, the thick forest in the background can soon become a waste like the area to the right in this picture. (MacMillian Export Co. photo.)

When Miss Hughes challenged the class with the problem *What can we do?* the pupils decided that the first thing they should do was to find out all they could about forest conservation.

Norman and Bill reported later. Forest fires destroy tens of thousands of acres of trees each year. Not only older trees, but young trees and even seeds lying on the ground are burned. The chief causes of forest fires are *careless campers,* who allow campfires to spread to near-by bushes, *thoughtless smokers,* who toss lighted matches and cigarettes into dry leaves and



During a forest fire, a wall of flame travels with the speed of wind and destroys everything in its path—trees, wild animals, and their homes. These two pictures show the awful difference a forest fire can make. (Photos courtesy of Canadian Forestry Association and American Museum of Natural History.)

twigs, and *settlers burning off brush,* whose fires get out of control.

Many burned-over areas are being *reforested.* This picture shows new trees growing where they have been planted among the burned trunks of the trees that were growing there before they were destroyed by fire. (Sask. Bureau of Publications photo.)

Modern methods of fighting forest fires include: men stationed in high look-out towers to watch for fires; crews of trained fire fighters; fire guards or lanes cut through the woods; radio-equipped trucks to transport men, equipment, and water; and airplanes to spot fires, drop fire fighters by parachute, and send radio messages about the fire to men on the ground.

Bob and Gordon reported: New methods of lumbering and of managing forest areas are being developed. The idea is growing that trees are a crop that can be grown over and over again on the same land. Methods of cutting trees are being used that leave many seedlings and middle-age trees to grow into old trees for harvesting. Trees must be left to produce and scatter seeds to produce more trees.

This airplane is laying down a strip of poison spray about 110 feet wide and 2½ miles long. Later, other strips of the insecticide (insect poison) will be sprayed until the area has been completely covered. (Photo by Bert Beaver, Canada Wild Features Service.)

Jack said people must (1) Build a camp-fire in a safe place. (2) Make sure it is out—cover it well with water (or soil) and rake over the ashes to make sure no live spark remains.

Conservation means to use wisely without waste. The aim in forest conservation is to use trees for our needs and still have more growing in the forests.

Soil Conservation

In areas concerned with the growing of crops, soil conservation is tremendously important. Not only is it important to the farmers and gardeners at present using the land, but it is equally important to the farmers and gardeners of the future.

You will remember that we learned in the *garden* chapter how soil fertility must be maintained. The supply of plant food materials in the soil should not be destroyed.

We have also learned how important it is to protect the soil from damage by wind and water. The blowing and washing away of the soil by wind and water is known as *erosion* (ē-rō'zhon). The prevention of soil erosion is a very important problem for all farmers and gardeners.

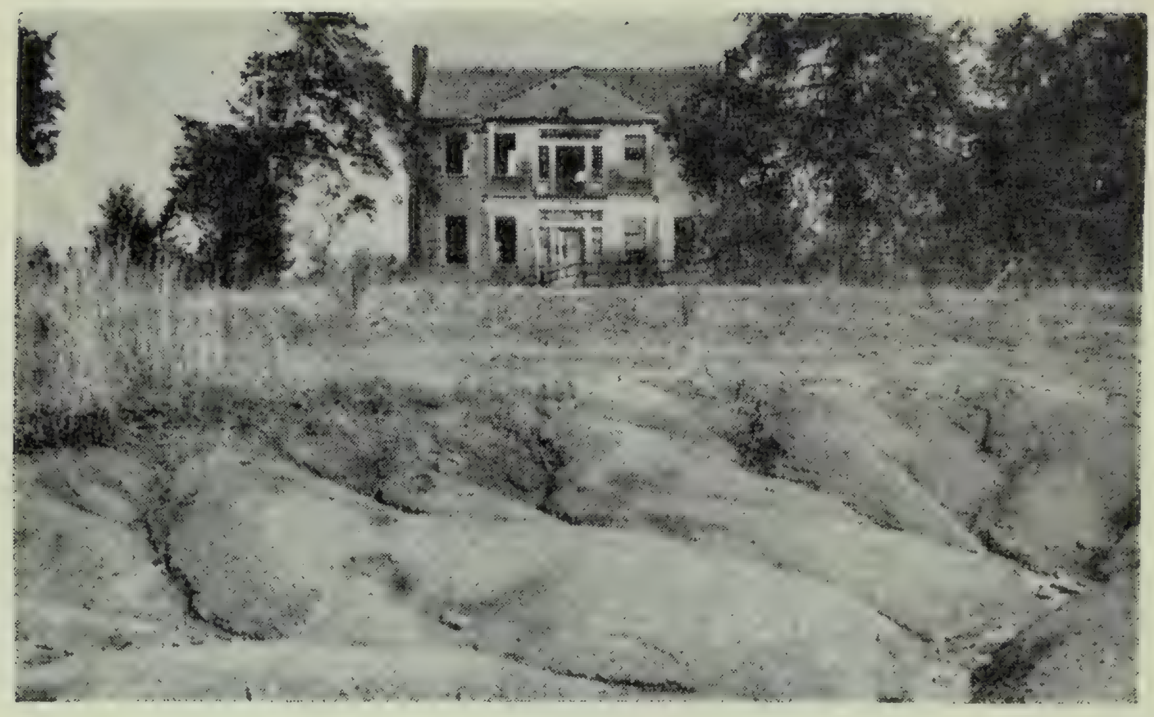
STUDY THE SOIL EROSION PROBLEM IN YOUR OWN AREA. Go out in the fields after a heavy rain and during a wind storm.

1. Compare erosion on bare soil and on soil covered by grass or trees.

2. Does fine or lumpy soil blow more?

3. Is water erosion worse when the soil has been cultivated across the slope of the land or up and down it?

4. Some methods of cultivation leave more plant material in the soil than others. Which encourages or prevents soil erosion?



This photograph shows what may happen when soil erosion is not prevented. Not only is the soil lost, but the farm cannot be maintained as a home. (U.S. Conserv. Service photo.)

5. Report your observations to your class for discussion and group summary.

Problems and Things To Do

1. Conservation does not mean that forests and soil should not be used. Be sure that you clearly understand what it does mean. Be ready to tell about the conservation of wild life, forests, and soil.

2. The pupils of Western School decided there were many things they could do in connection with conservation. Prepare a list of things that *you and your classmates* can do. A few suggestions are:

Learn how to help and protect birds.

Learn how to report a forest fire and what to do in case of fire.

Set a good example when hiking or camping by *always* practising conservation.

3. Make a list of ways in which wild life (plants and animals) and forests are valuable. Why should we do all we can to preserve the natural beauty and wealth of our country?

4. Make a list of the ways in which your life would be different if there were no trees (*a*) growing wild, (*b*) around your home, (*c*) in your town or city.

5. Plant a tree a year in your school grounds.

6. Why is it wrong to (*a*) gather large bouquets of all the wild flowers you can find, (*b*) pull wild flowers up by the roots?

7. Prepare a set of rules in connection with the preservation of wild life and natural beauty, for example: "Enjoy wild flowers where they grow, leave them there for others to enjoy." "Protect wild life always, going to and from school, when picnicking, when camping." "Always break a match in two before throwing it away."

8. Know and obey the game laws. Tell others about them.

9. Keep yearly tree records and bird records.

10. Start a *conservation* scrap book. Include pictures of trees. birds, forest fire-fighting equipment, etc. *Make each picture tell an important fact about conservation.*

11. Visit places where conservation is being practised: fish hatchery; tree planting; fire tower; wild life sanctuary, game preserve, park, or others.

12. Make your school grounds a wild life sanctuary and conservation centre. Even on the open prairie much can often be done.

Care for windbreak and individual trees.

Plant trees and shrubs.

Keep the school grounds clean and tidy.

Establish several "beauty corners" and give them special care.

Make it a rule that birds, wild flowers, and trees are safe on the school grounds.

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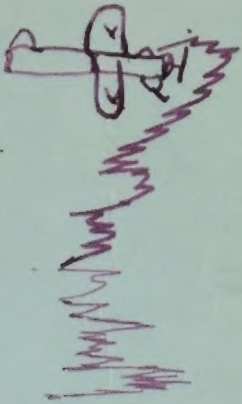

MP
Yellow
Green
yellow
Green

Red